OKB ILYUSHIN

A History of the Design Bureau and its Aircraft

Yefim Gordon, Dmitriy Komissarov and Sergey Komissarov

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Below: **The design bureau's more recent output has turned to civilian projects epitomised by the Ilyushin IL-96-300PU; this example is used by the Russian President.**

Opposite page: **Ilyushin's best-known World War Two type, the IL-2 *Shtoormovik*.**

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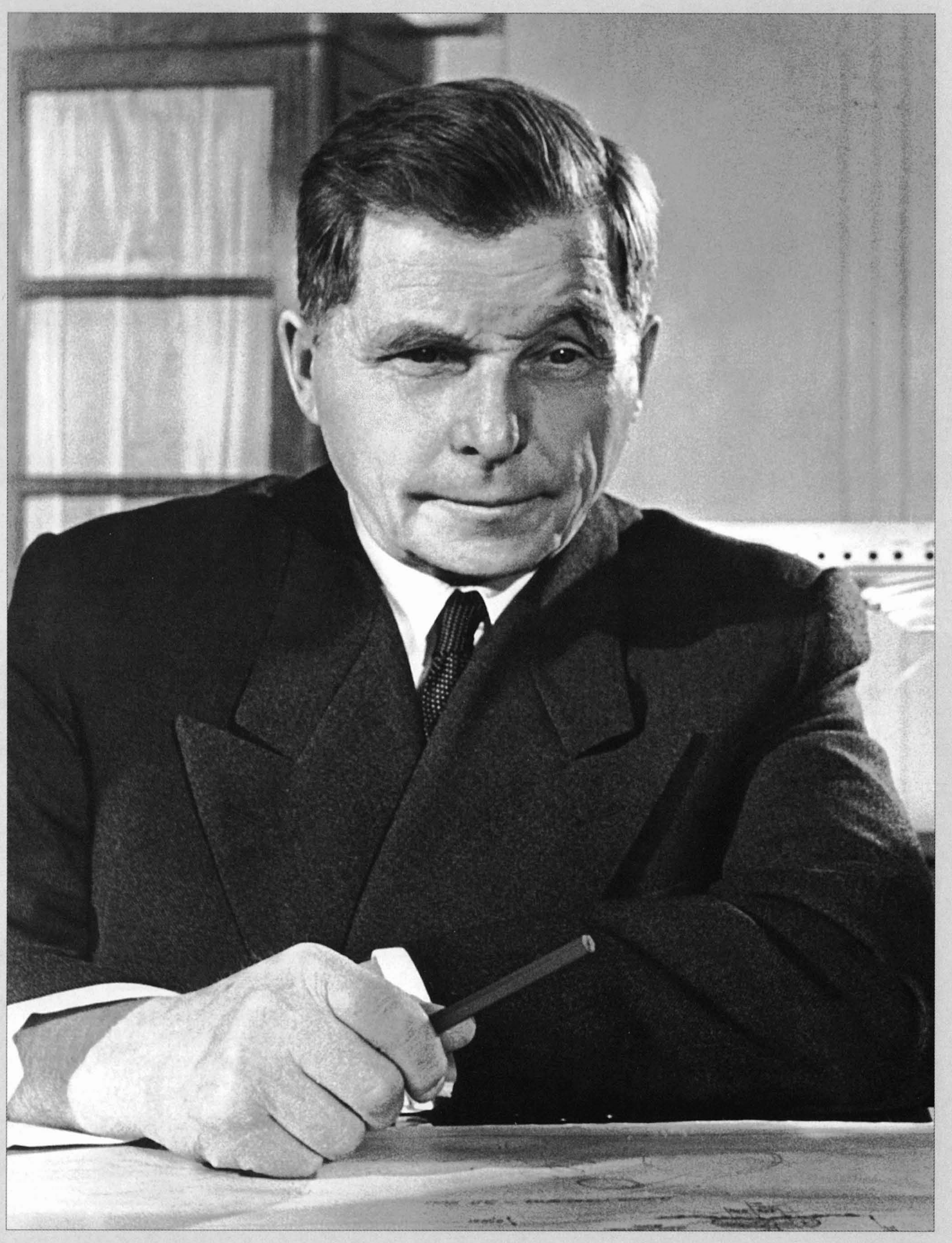


Sergey Vladimirovich Ilyushin, the founder of the OKB-240 aircraft design bureau.

A BRIEF HISTORY OF THE ILYUSHIN OKB

The Design Bureau led by Sergey Vladimirovich Ilyushin in his lifetime and now headed by his disciples and bearing his name is often referred to as the Ilyushin OKB (*opytno-kon**strook**torskoye byu**ro*** – experimental design bureau). This general term covers an organisation which, at different times, bore different names and had a different status and even location. The present short outline seeks to describe the formal evolution of the Design Bureau, detailing the various names under which it has existed, the dates of its transformations and the like. The actual design activities are not the subject of this account (they are mentioned briefly in Ilyushin's biography and dealt with in the main body of the book).

As noted in the following outline of Sergey Ilyushin's biography, during the initial stages of his career in aviation he was not directly engaged in aircraft design work. His tasks lay primarily in the field of administration, control and planning of activities of the aircraft industry and its design bureaux. It was in 1931 that Ilyushin came for the first time into a position formally equal to that of a leader of a design bureau. In August of that year the so-called Central Design Bureau (TsKB – *Tsen**trahl'**noye kon**strook**torskoye byu**ro***) that had been set up at Plant No.39 under the control of the Technical section of the OGPU (Chief Political Directorate, the then-current name of the Soviet secret service) was incorporated into TsAGI and merged with its subdivision – AGOS ([*Otdel*] *avi**ahtsii**, **ghid**roavi**ahtsii** i **op**ytnovo samo**lyo**tostro**yen**iya* – [Section for] Aviation, Hydroaviation and Prototype Construction). An order to that effect was issued on 27th August 1939. The new organisation received the name TsKB TsAGI (the Central Design Bureau of the Central Aero- & Hydrodynamics Institute). Ilyushin was appointed chief of TsKB TsAGI; in this capacity he also was appointed deputy to N. E. Paufler, the new chief of TsAGI.

TsKB TsAGI cannot yet be regarded as Ilyushin's own design bureau; his position as its chief had more to do with administration than with design work which was conducted within several subdivisions of this organisation under the direction of aviation engineers directly responsible for the actual design.

On 25th May 1932 TsKB TsAGI was reorganised into SOS TsAGI (SOS = ***Sek**tor **op**ytnovo stro**it**el'stva* – prototype construction section); Ilyushin was appointed chief of the new organisation. Again, this meant overall administrative responsibility. The actual design activities were concentrated in the KOSOS (*Kon**strook**torskiy ot**del sek**tora **op**ytnovo stro**it**el'stva* – design section of SOS) headed by Andrey Nikolayevich Tupolev, Ilyushin's former deputy at TsKB TsAGI. KOSOS comprised several teams specialising in the design of aircraft for various missions (fighters, bombers and so on).

The new organisation remained rather unwieldy; excessive centralisation was not conducive to enhancing the creative character of the activities of aviation engineers engaged in design work. Being well aware of this, Ilyushin came up with the initiative of a new re-organisation; he suggested that KOSOS be split into two independent organisations dealing respectively with light and heavy combat aircraft (the former category included fighters, reconnaissance aircraft and attack aircraft while the latter comprised bombers). Ilyushin's proposal was approved. An order issued by GUAP (***Glahv**noye oopravl**en**iye aviatsi**on**noy pro**mysh**lennosti* – the Main Directorate of Aircraft Industry) on 13th January 1933 decreed the setting up of a Prototype Aircraft Construction Design Bureau at Plant No.39. The same order relieved Ilyushin from the duties of deputy chief of TsAGI and appointed him chief of the mentioned new design bureau at Plant No.39 which was to specialise in the projecting of light combat aircraft. The appropriate design teams were transferred to the new design bureau from KOSOS TsAGI. In addition, it incorporated the staff of the disbanded BNK (*Byu**ro no**vykh kon**strook**tsiy* – Bureau of New Designs), a team previously led by the Frenchmen Paul Aimé Richard and André Laville. The design teams which remained in KOSOS TsAGI under the guidance of A. N. Tupolev were to engage in the designing of heavy aircraft.

Ilyushin chose to retain the old name of TsKB for the newly established design bureau at Plant No.39; moreover, he also retained the system of independent design teams specialising in different types of aircraft, armament, production methods and the like. For example, Team 1 headed by Sergey Aleksandrovich Kocherigin was engaged in designing attack and reconnaissance aircraft, Team 2 led by Nikolay Nikolayevich Polikarpov was tasked with designing fighter aircraft and so on. Ilyushin exercised overall leadership which can be compared to the present role of General Designer at a big design bureau. However, the authorship of designs evolved in these independent design teams is attributed to the leaders of these teams – Polikarpov (the I-15 and I-16 fighters), Kocherigin (the R-9 and other reconnaissance and attack machines), Gheorgiy Mikhaïlovich Beriyev (seaplanes) and so on. The growing scope of work handled by the TsKB reached a stage at which the overly centralised structure of this organisation began to hamper its efficiency. Ilyushin came to the conclusion that further work on projecting new aircraft would be better served by independent design teams, each with its own production facility (factory). He proposed splitting the TsKB into several Experimental (prototype) Design Bureaux (OKBs). His initiative met with approval, and the Government took the decision to establish a number of specialised OKBs for prototype aircraft construction. The first to leave the TsKB framework were the teams of Vladimir Antonovich Chizhevskiy and Beriyev; they were established respectively in Smolensk as BOK (*Byu**ro** o**sob**ykh kon**strook**tsiy* – Special Designs Bureau) and in Taganrog as TsKB MS (*TsKB mor**skov**o samo**lyo**tostro**yen**iya* – Central Seaplane Design Bureau).

From the summer of 1933 onwards Ilyushin commenced design work on his own project – the TsKB-26 fast bomber, initially classed as a 'short-range bomber' but later evolved into a long-range bomber. He personally headed the team of designers working on this project. This event signified the actual shaping of the organisation which later came to be widely known as the Ilyushin OKB, and is officially regarded as its birthday. Significantly, in July 1983 the OKB celebrated its 50th anniversary.

In September 1935 the former Team 3 was renamed into the OKB of Plant No.39 (OKB-39) by a special GUAP order. Sergey

Ilyushin Aviation Complex

Above: Sergey Ilyushin (front row, third from right) with the design staff of OKB-39.

Ilyushin was appointed Chief Designer of this OKB which was assigned Workshop No.81 of this plant as the OKB's production facility. Specialist from Teams 4, 5 and 6 who took part in the design work on the TsKB-26 and TsKB-30 were included into the staff of the new Design Bureau. The mentioned GUAP order was just a formal step lending official recognition to a design bureau which had already taken shape. The Central Design Bureau previously based at Plant No.39 ceased to exist; Ilyushin's OKB-39 became its legal successor (in Soviet practice, design bureaux usually were assigned the number of the Plant at which they were based). Yet, Ilyushin continued to use the in-house abbreviation TsKB for his projects right up to the outbreak of the war in 1941.

Ilyushin Aviation Complex

Sergey V. Ilyushin (front row, second from right) with the members of his design team.

In the period preceding the beginning of the Great Patriotic War in June 1941 OKB-39 was engaged in the design and service introduction of the DB-3 and BSh-2 (IL-2), the two aircraft that eventually became the mainstay respectively of the long-range bomber and attack elements of the Soviet Air Force.

At times, Ilyushin had to fight for the survival of his organisation. In March 1941 Aleksey Ivanovich Shakhurin, People's Commissar of Aircraft Industry, issued an order transferring the OKB-39 to Plant No.18 in Voronezh. Ilyushin reacted to this by writing a letter to Stalin, pointing out that implementation of this order would be tantamount to liquidating the Design Bureau and would thus seriously impair the design potential of the aircraft industry. His logic prevailed and the OKB remained in Moscow.

The outbreak of the war, accompanied by initial serious defeats of the Red Army, led to a massive evacuation of industrial enterprises, including aircraft factories and design bureaux, to the East. This affected also the OKB-39 led by Ilyushin. In October 1941 it was temporarily transferred to one of the evacuated plants (ironically, it was Plant No.18 which had moved from Voronezh to Kuibyshev). When the Red Army routed German troops in the Battle of Moscow in December 1941 and launched a counter-offensive, some of the evacuated plants and design bureaux were transferred back to Moscow where they re-established themselves, sometimes on other premises than before. On 16th April 1942 the Ilyushin OKB returned from Kuibyshev (now Samara) to Moscow and settled on the territory of Plant No.240 which before the war had manufactured the DB-3 bomber. On 21st April 1942 People's Commissar of Aircraft Industry Shakhurin issued an order appointing Sergey Ilyushin director and Chief Designer of Plant No.240. Accordingly, the design bureau came to be known as OKB-240 from then on. It had its premises on the west side of Moscow's Central airfield named after Mikhail V. Frunze, popularly known as Khodynka. In 1946 the OKB's premises were expanded at the expense of the co-located Plant No.482 which became part of Plant No.240 (in 1946 a decision was taken to disband the resident small OKB-482 led by Vladimir Mikhaïlovich Myasishchev; its staff was transferred to Ilyushin's OKB, but later partially returned to Myasishchev when his design bureau was re-established in 1951).

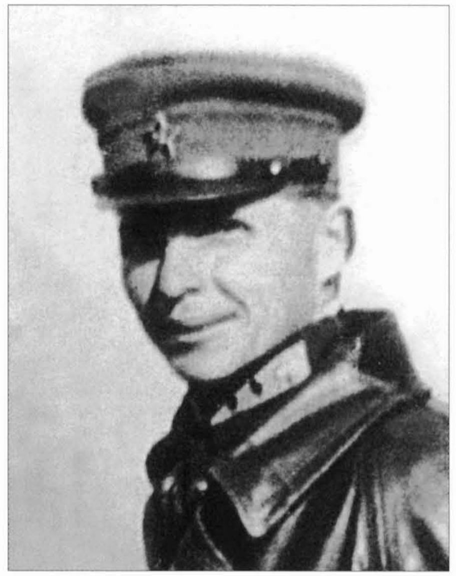
In addition to premises in Moscow, the OKB had flight test and development facilities at the airfield of the Flight Research Institute named after Mikhail Mikhaïlovich Gromov (LII – ***Lyot**no-**issle**dovatel'skiy institoot*) in Zhukovsky south of Moscow.

In 1966 OKB-240 was renamed MMZ *Strela* (Arrow; MMZ = ***Mos**kovskiy **mashi**no-stroitel'nyy **zavod***, Moscow Machine-building Plant). When Ilyushin passed away in 1977, the name was changed to MMZ named after S. V. Ilyushin. Popularly it was also known forthwith as OKB named after Ilyushin, or simply the Ilyushin OKB.

In 1989-92 the aircraft industry of the Soviet Union and, after its dissolution, of Russia underwent restructuring which led to the renaming of various enterprises and organisations. Later, when the aircraft industry was affected by the general process of privatisation and emergence of joint-stock companies, these names were changed again. Thus, as of 24th December 1991 MMZ named after S. V. Ilyushin became the Aviation Complex named after S. V. Ilyushin. On 14th April 1994 it became the 'Aviation Complex named after S. V. Ilyushin' Joint-Stock Co. (more conveniently termed in English the Ilyushin Aviation Complex).

The changes described above affected not only the names of enterprises. The market economy and new economic realities necessitated the introduction of radical changes into the relationship between design bureaux and production plants which in the Soviet period were separate entities independent from each other structurally and commercially. The new situation made it necessary to integrate design bureaux with production plants in order to fund the activities of the former (the state was no longer in a position to provide the required funding from budgetary means). As a result of this development, the Ilyushin OKB in its new guise was compelled to enter a 'marriage' with the Voronezh Aircraft Plant, now restyled Voronezh Joint-Stock Aircraft Production Association (VASO), which had manufactured the IL-86 airliner and now produces the IL-96-300 airliner. In July 1994 Russian President Boris N. Yeltsin signed a decree envisaging the establishment of the Ilyushin Aircraft-Manufacturing Holding Co. comprising the Ilyushin Aviation Complex and VASO. In other words, the OKB as such is to be a part of a complex embracing all stages of aircraft design, series production and marketing. The latter aspect has been dealt with, in particular, by setting up a special subsidiary, the Ilyushin Finance Co., which was established with the express purpose of promoting the sales of Ilyushin airliners by offering attractive financial terms based on leasing.

In early 1999 the Ilyushin Interstate Aircraft Manufacturing Company began to take shape. It was envisaged that the Ilyushin Holding Company would comprise the Ilyushin OKB, the Voronezh Aircraft Production Company and the Tashkent Aviation Production Association named after Chkalov (the latter has been responsible for the series



Ilyushin Aviation Complex

Above: A wartime photo of Sergey Ilyushin in military uniform.

production of the IL-76 transport aircraft and the IL-114 airliner). The first attempts to merge the aircraft-manufacturing plants with the Ilyushin Aviation Complex were undertaken in 1995 and 1997 in the guise of creating a financial-industrial group.

However, this process proved to be arduous and beset with many problems; in particular, the relationship between the Ilyushin Aviation Complex and the Tashkent plant belonging now to the sovereign Uzbekistan proved to be a source of problems and frictions. As of this writing, no final agreement has been reached yet on the terms of the Tashkent plant's participation in the common structure.

Ilyushin Aviation Complex

A post-war picture of Sergey V. Ilyushin (still in military uniform and in the rank of Lieutenant-General).

Ilyushin Aviation Complex

Above: General Designer Sergey V. Ilyushin in his study in the 1960s.

Still more ambitious plans for restructuring Russia's aircraft industry were in hand in 2001; they envisaged the formation of several holding companies which would comprise a number of design bureaux and production plants existing as independent entities at present. In one of the versions of these plans, the Ilyushin Aviation Complex was visualised as the central organisation around which all commercial aviation design and production activities should be united. These schemes proved still more difficult to implement, and at present it is uncertain what course these developments will take eventually.

A characteristic feature of the Ilyushin Aviation Complex's activities in the recent years is its participation in joint ventures with other aircraft manufacturers both at home and abroad. These activities with regard to the IL-96 (co-operation with the Boeing Co.) are covered in the appropriate section of the book. One more example is the participation of the Ilyushin Aviation Complex in the RRJ (Russian Regional Jet) programme in co-operation with the Sukhoi Civil Aircraft Company and the Boeing Commercial Aircraft Group. Faced with harsh economic realities, the Ilyushin enterprise wages a struggle for preserving and developing Russia's potential in the field of civil aircraft construction.

General Designer Sergey Ilyushin

Sergey Vladimirovich Ilyushin was born on 18th March 1894 (old style) in a peasant family which lived in the Vologda province (in the northern part of Russia west of the Urals). After graduating from school he had to start earning his living at an early age. In 1910 he came to St. Petersburg in search of work; there he witnessed demonstration flights undertaken by Russian pilots. They left a lasting impression on him, but Ilyushin had to try many a job before starting his career in aviation. That happened during the First World War when Ilyushin was enrolled in the ground maintenance team at one of the airfields in St. Petersburg. Performing the job of a motor-mechanic, he took much interest in flying and had a chance to obtain some acquaintance with flying techniques. In 1916 he was admitted to a newly-established flying school in Moscow where he mastered the art of piloting a Voisin trainer and received a pilot's licence.

The revolutionary events of 1917 put an end to this period of Ilyushin's career. He was demobilised and returned to his native village where he got a position in the local administration. In 1919, when the Russian Civil War was at its peak, Ilyushin was enrolled in the Red Army, but not in the capacity of an airman. He was included in a team of technicians of the Northern Front which was tasked with finding, repairing and refurbishing damaged aircraft or aircraft written off due to poor condition, so as to make up for the acute shortage of flying machines in the Red Army. It was on one such mission that Ilyushin and his fellow technicians got hold of a damaged Avro 504 biplane which had been flown by a White Guard airman. The aircraft was promptly sent to Petrograd (the new name of St. Petersburg) where it was copied and put into production as the U-1 (U = *oo**cheb**nyy* [*samo**lyot***] – trainer). Later Ilyushin was transferred to the Southern Front where he performed similar duties.

In June 1921, after the end of the Civil War, Ilyushin was summoned to Moscow where he entered the Institute of Red Air Fleet Engineers. At that time this was the only educational institution in Russia specialising in the training of aviation specialists.

In June 1922 the institute was transformed into the Air Fleet Academy named after N. Ye. Zhukovskiy (Professor Nikolay Yegorovich Zhukovskiy was renowned for his studies in the field of aerodynamics). Ilyushin studied at the engineering faculty which trained specialists for the aircraft industry. Concurrently, Ilyushin engaged actively in design work on gliders on a voluntary basis. In 1923 he designed and built a training glider. Designated AVF-3 (AVF = *Aka**dem**iya Voz**doosh**novo **Flot**a*, Air Fleet Academy), it was successfully tested in the course of competitions held on the Crimea Peninsula. Ilyushin was rewarded by a special certificate granting him the right to engage forthwith in the design of gliders. His work in this direction resulted in a further three projects: the AVF-4, AVF-14 and AVF-5. All three gliders were completed by the autumn of 1924. They displayed good performance at the second All-Union Glider Competitions in September 1924, especially the AVF-4.

Ilyushin's next (and last) glider was the AVF-21 sailplane which was submitted for competitions in the autumn of 1925. This glider was ill-fated: together with several other machines it was destroyed at an airfield by a sudden hurricane.

On 10th April 1926 Ilyushin defended his graduation thesis which was a project of a fighter. Upon graduation he was conferred the rank of military engineer-mechanic of the Air Force and received an appointment to a very important post in the Scientific-Technical Committee of the Air Force Directorate. The tasks of this committee consisted primarily in evolving and implementing a programme of rearming the Red Army Air Force with new, more modern types of aircraft and in issuing technical requirements for prototype aircraft, engines, armament and equipment. Ilyushin was appointed chief of the aircraft construction section of the committee.

The design bureaux of the Soviet aircraft industry developed their projects in response to technical requirements issued by the Scientific & Technical Committee of the Air Force Directorate and sent their projects for consideration to this committee and to the Technical Council of the Aviatrust. Members of the aircraft construction section headed by Ilyushin thoroughly studied each project and gave their assessment with regard to its suitability for prototype construction. Ilyushin personally took an active part in evolving technical requirements for fighters, bombers, reconnaissance aircraft, attack aircraft, trainers and seaplanes which were built in the USSR in the late 1920s and the early 1930s. These requirements were implemented in such machines as the Polikarpov I-3 and Tupolev I-4 fighters, the Tupolev TB-1 (ANT-4) bomber, the Polikarpov U-2 (Po-2) trainer and the Polikarpov R-5 reconnaissance aircraft.

However, the efforts of Soviet designers were not always crowned with success. Some prototypes never made it to production lines because of serious design flaws. There were numerous accidents involving prototype aircraft. The late 1920s were marked in the Soviet Union by a wave of repressions against the so-called saboteurs among 'bourgeois specialists'. This wave swept over the aircraft industry as well. Many prominent aircraft designers, including Dmitriy Pavlovich Grigorovich and Nikolay Polikarpov, were arrested and routinely accused of sabotage. The country's leaders made a 'wise' decision: it would be more expedient to make the arrested engineers work in detention than to execute them. In 1929 a special design bureau made up of arrested specialists was set up under the control of the OGPU. This was the TsKB-39 (Central Design Bureau at Plant No.39). In the course of the subsequent two years the inmates of this prison design bureau produced several prototype aircraft, including the successful I-5 fighter which was adopted for series production. The efficient work of the TsKB-39 prompted the Government to concentrate within the framework of a single organisation all aircraft designers working on prototype construction in Moscow.

The new organisation was created by incorporating the TsKB-39 into TsAGI (*Tsen**trahl'nyy** **a**ero- i **ghid**rodina**mich**eskiy insti**toot*** – Central Aero- & Hydrodynamics Institute) and merging the TsKB-39 and AGOS TsAGI to form a unified design bureau called TsKB TsAGI. An order to that effect was issued on 31st August 1931. Sergey Ilyushin was appointed chief of TsKB TsAGI and deputy chief of TsAGI. In May 1932 this design bureau was transformed into SOS TsAGI, comprising KOSOS (the design section) headed by Andrey N. Tupolev. A further reorganisation effected in January 1933 resulted in the splitting of KOSOS into two independent bodies. One of these was the Prototype Aircraft Construction Design Bureau at Plant No.39 which was to specialise in the projecting of light combat aircraft. Ilyushin was relieved from the duties of deputy chief of TsAGI and appointed chief of the new design bureau at Plant No.39 which retained the old name of TsKB. Also retained was also the system of independent design teams specialising in different types of aircraft, armament, production methods and so on. At a later stage these teams, one by one, were transformed into independent design bureaux with their own experimental production facilities at different plants. What remained was the core element, Team 3 set up by Ilyushin and headed personally by him with the purpose of implementing his own project – that of a high-speed bomber. As already related, in September 1935 (according to some sources, in August 1936) Team 3 was renamed by a special order issued by GUAP into the OKB of Plant No.39. Sergey Ilyushin was appointed Chief Designer of this OKB. The project in question, the TsKB-26, became a starting point for creating the DB-3 long-range bomber, Ilyushin's first aircraft to go into production.

Ilyushin was not allowed to concentrate solely on design activities; his recognised abilities as an organiser were much in demand. In December 1935 he was appointed chief of the newly established section of prototype aircraft construction in GUAP. A year later, when the People's Commissariat of Defence Industry was set up, Ilyushin was appointed chief of the Main Directorate of Prototype Aircraft Construction of that Commissariat. He held this post until 1939 when he asked to be relieved of it in order to devote himself entirely to the work on the new attack aircraft, the BSh-2, which was in progress at that time. That was the prototype of the IL-2, an aircraft that came to occupy a special place in the Red Army's arsenal during the war.

Development of attack aircraft and bombers became the main occupation of the Ilyushin OKB during the war, resulting in numerous improved versions of the IL-2 and

Ilyushin Aviation Complex

Wearing the two Gold Star orders that went with his (at the time) two Hero of Socialist Labour titles, Sergey V. Ilyushin is pictured here in the late 1960s (shortly before retirement) together with his son, Colonel Vladimir Sergeyevich Ilyushin, Chief Test Pilot of the Sukhoi OKB.

Aviation Encyclopaedia

Above: Ghenrikh Vasil'yevich Novozhilov, twice Hero of Socialist Labour, succeeded Sergey V. Ilyushin as the OKB's head.

the DB-3F (IL-4) and in the emergence of the new IL-8 and IL-10 attack aircraft, the latter eventually supplanting the IL-2 on production lines.

During the post-war decades Ilyushin displayed to advantage his abilities of organiser and designer. As the leader of his design staff, he was very exacting but nevertheless considerate towards his subordinates. Being a modest man, he placed much confidence in his colleagues and succeeded in creating a team of high-class professionals imbued with creative spirit and a sense of duty. Ilyushin created his own school in aircraft construction; it is characterised by simple and rational technical solutions, aiming at utmost efficiency and reliability, a long service life, large-scale production and wide operational use.

The list of aircraft developed under Ilyushin's guidance is truly impressive, even though some of them did not progress further than the prototype stage. The wartime series of attack aircraft (the IL-2, IL-8 and IL-10), the progenitor of which – the IL-2 – ranks among the world's most famous aircraft, was followed up by such types as the IL-10M, IL-20, IL-40, IL-42 and IL-102. The DB-3 and IL-4 bombers, which had formed the mainstay of the Soviet long-range aviation during the war, were followed up in the post-war years by the IL-28 jet bomber which remained for a long time the most important tactical jet bomber in the Soviet Air Force. Ilyushin also produced several bomber prototypes: the IL-6, IL-22, IL-30, IL-46 and IL-54.

A special chapter in the design activities of Ilyushin and his design staff is the creation of airliners and transport aircraft which, from the mid-1950s onwards, became the OKB's main specialisation. The piston-engined IL-12 and IL-14 airliners became the main types on the routes of the Soviet airline Aeroflot during the first post-war decade. The advent of gas turbine engines into commercial aviation was marked by the creation of the IL-18 turboprop airliner which gained the reputation of a workhorse of the Soviet air transport. It was followed by the turbofan-powered IL-62, a long-haul airliner which came to be called Aeroflot's flagship. The inception of the IL-76 transport aircraft, later becoming a household name in transport aviation, also took place when Ilyushin was still at the helm.

Aircraft created by the Ilyushin OKB are noted for their longevity. The IL-14 airliner remained in service for more than forty years. The IL-18 turboprop airliner and the IL-62 are in operation to this day. The IL-76 freighter has been in commercial and military operation for more than a quarter of a century and is still going strong.

Civil aircraft became the dominant direction of Ilyushin's activity as a designer, but numerous military and special-purpose derivatives of his passenger and transport aircraft, suffice it to mention the IL-38 ASW aircraft, continued to represent a sizeable contribution to the country's defence capabilities.

In 1956 Chief Designer Sergey Ilyushin was promoted to the rank of General Designer. In 1967 he became Colonel-General of Engineering and Technical Service. In 1968 he was elected Member of the Soviet Academy of Sciences (the degree of Doctor of Technical Sciences had been conferred on him as early as 1940).

Via AVICO-Press

Ghenrikh V. Novoshilov with Tatiana V. Anodina, Chief of the CIS Interstate Aviation Committee (in civil aviation uniform).

Ilyushin resigned from the post of General Designer in 1970 for reasons of failing health. In the remaining seven years of his life (he died on 9th February 1977) Ilyushin preserved close ties with the design bureau staff, with his former colleagues who continued to benefit from his rich experience.

Ilyushin's activities in the field of aircraft design won him a deserved fame and recognition. He was conferred the title of Hero of Socialist Labour three times (in 1941, 1957 and 1974). He was awarded Stalin Prizes seven times (in 1941, 1942, 1943, 1946, 1947, 1950 and 1952); in 1960 he received the Lenin Prize and in 1971, the State Prize. Ilyushin was also awarded numerous prestigious orders and medals.

Ghenrikh V. Novozhilov, Sergey Ilyushin's Successor

Ghenrikh Vasil'yevich Novozhilov was born on 27th October 1925 in Moscow in the family of a serviceman. Having taken an interest in aviation from early childhood, he decided to devote his life to aircraft design. In 1942 he entered preparatory courses at the Moscow Aviation Institute. During his student years he took part in the work of a laboratory dealing with liquid-fuel rocket motor design. In 1948, shortly before graduating the institute, Novozhilov was sent as probationer to the Ilyushin OKB. Sergey Ilyushin exercised personal supervision of the work of the would-be MAI graduates assigned to his design bureau; he took notice of the talented student who chose the design of a swept-wing transonic bomber as the subject for his graduation thesis.

Novozhilov successfully defended his thesis on 25th March 1949 and was hired full-time by the OKB, becoming a member of the team engaged in fuselage design. In this capacity he took part in the design of the IL-14 airliner, the IL-40 attack aircraft, the IL-46 jet bomber and the IL-54 transonic bomber. Novozhilov quickly proved his worth as an industrious engineer capable of creative and unorthodox approach to design problems. During the subsequent stages of his work in the OKB he had a chance to get closely acquainted with all aspects of aircraft design and production. For example, he worked in the role of project engineer responsible for the construction of the IL-54 prototype. In his capacity as the OKB's representative at the production facility and at flight tests he had an opportunity to acquire wide-ranging experience and profound insight into various aspects of aviation.

On 22nd September 1958 Novozhilov was appointed deputy project chief of the IL-18 airliner. This was done at Ilyushin's initiative. From that moment and up to 1964 Novozhilov was responsible for the operational service of all Ilyushin types. A task of crucial importance in this respect was the introduction of the IL-18 turboprop airliner into service. Novozhilov was very active in tackling the numerous problems that inevitably arise at this stage, including investigation of accidents; he made also a major contribution to the promotion of the IL-18 sales to foreign customers.

This work brought Novozhilov into contact with many prominent aviation specialists, the leaders of design bureaux, research institutes, test pilots and so on. This was an extremely valuable and actually indispensible school for the future General Designer.

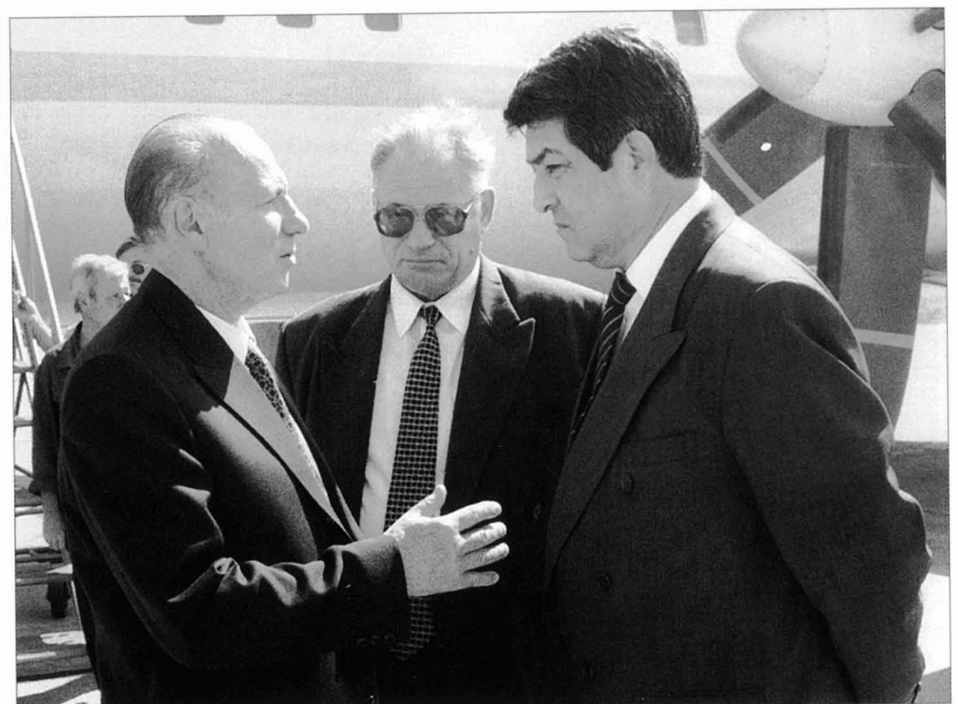
Novozhilov's career had an unusual aspect: at one time he was responsible for the reliability of the VIP aircraft used by members of the Government for their official visits. In this capacity he accompanied the country's leaders during their travels abroad.

On 15th October 1964 Novozhilov was appointed Chief Designer and Ilyushin's (the General Designer's) first deputy. In this capacity he was responsible for the testing and service introduction of the IL-62 airliner.

Eventually failing health compelled Ilyushin to resign from the post of General

Via AVICO-Press

Above: Ghenrikh V. Novozhilov is interviewed by the Russian 'Vesti' TV channel at one of the Moscow airshows. Tashkent Aircraft Production Association General Director V. P. Kucherov is on the left.



Via AVICO-Press

Ghenrikh V. Novozhilov discusses production matters with Uzbek Prime Minister U. T. Sultanov.

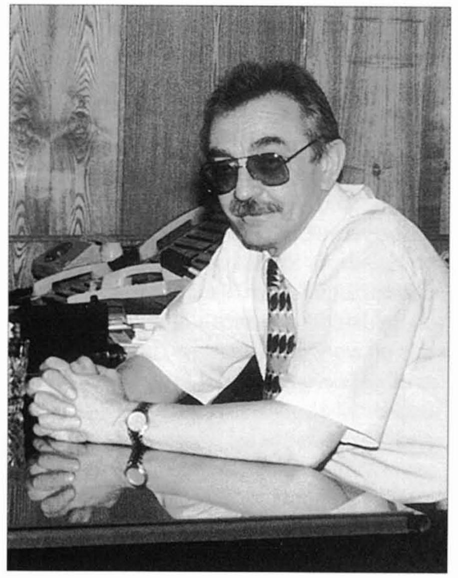
Via AVICO-Press

General Designer Ghenrikh V. Novozhilov in his study.

Designer. On 28th July 1970 Novozhilov was appointed General Designer, succeeding Sergey Ilyushin in that role. This was done in accordance with Ilyushin's wishes; he had long regarded Novozhilov as the future leader of the OKB.

The first project to be developed by the OKB under the new General Designer was the IL-102 attack aircraft, based on the preceding IL-40 and IL-42 projects. The IL-76 airlifter and the IL-86 widebody airliner, conceived not long before Ilyushin's resignation, were also among the first projects, implementation of which was the prime responsibility of Novozhilov. Other major projects developed under Novozhilov include the IL-96-300 widebody airliner, the IL-114 medium-haul turboprop airliner and the IL-76MF transport aircraft. At present the design bureau headed by Novozhilov and bearing the name of its founder (the Ilyushin Aviation Complex) is engaged in work on several prospective designs of airliners and transport aircraft. These include the work on the IL-214 (MTA) multi-purpose transport aircraft in co-operation with India; on the RRJ (Russian Regional Jet) family of aircraft in co-operation with the Sukhoi, Yakovlev and Boeing companies; and on the MS-21 short/medium-haul airliner with Yakovlev.

Novozhilov's outstanding contribution to the development of aviation technology and air transport has been duly acknowledged, winning him a Lenin Prize in 1970, the titles of Hero of Socialist Labour (twice) and many prestigious orders and medals. In addition to practical design work, Novozhilov has been active in theoretical studies in the field of aerodynamics, weight optimisation, prospective basic layouts, structural strength, enhancement of aircraft's reliability and other aspects of aeronautics. He was awarded the degree of Doctor of Technical Sciences in 1975; in 1984 he was elected Member of the Academy of Sciences of the USSR (now Russian Science Academy) in 1984.



Via AVICO-Press

V. V. Livanov, Director of the Ilyushin Aviation Complex's prototype construction shop.

Via AVICO-Press

The executives of the Ilyushin Aircraft Complex and a Kazakh delegation headed by Prime Minister U. T. Sultanov at the Ilyushin AC's premises (note the company logo on the wall) during the IL-114 airliner's type certificate issuance ceremony.

ATTACK AIRCRAFT AND FIGHTERS

1

I-21 (TsKB-32) fighter

Fighter aircraft design was not among the main directions of Sergey V. Ilyushin's work in the field of aircraft construction. Yet, he paid tribute to this variety of aviation hardware as well. One may recall that Ilyushin had prepared a project of a fighter as his graduation thesis at the Zhukovskiy Air Fleet Academy way back in 1926. Not surprisingly, he also tried his hand at it in the mid-1930s when design bureaux were tasked by the Government with developing new high-speed fighters. Ilyushin's design bureau developed a project of a fighter known in-house as the TsKB-32; its service designation was I-21. The aircraft was to be powered by a Mikulin AM-34RNF (also rendered as AM-34FRN) liquid-cooled Vee-12 engine delivering 1,200-1,250 hp for take-off. Two specially modified examples of this rather heavy engine were ordered for the first two prototypes. The I-21 (TsKB-32) was expected to attain a maximum speed close to 600 km/h (373 mph). It was an all-metal low-wing cantilever monoplane with retractable undercarriage. The initial armament fit comprised four 7.62-mm ShKAS machine-guns; later it was changed to two 20-mm ShVAK cannon. In both versions the weapons were placed in the wings outside the propeller disc area.

The advanced development project of the fighter, together with the full-scale mock-up, was presented to Chief of the Air Force Directorate Yakov Alksnis on 27th October 1935. The aircraft had remarkably clean contours and featured an enclosed cockpit; its sharply tapered wings had a straight trailing edge and a swept leading edge.

From the outset it was envisaged that the two prototypes would feature different engine cooling systems. The first prototype was to be equipped with an evaporation cooling system which was regarded as an effective means of reducing the aircraft's drag by dispensing with bulky radiators projecting into the slipstream. The use of the evaporation cooling system was expressly prescribed by GUAP. On the I-21, the evaporation cooling system was incorporated into the wing centre section which had a double skinning made of thin stainless steel sheets. The water circulating in the cooling system was evaporated by the heat of the cylinders and the vapour was sent into the space between the double skin sheets; there it condensed, the resulting water being further cooled by the slipstream around the wings. Then it returned to the cylinder jackets. Provision was made for a small retractable water radiator to be used during taxying and climb. The engine was fitted with a gearbox which, interestingly, did not reduce the propeller's rpm but served the purpose of raising the propeller thrust line; this helped improve the nose contours and permitted the use of shorter and lighter main undercarriage units. Another special feature of the engine was its crankcase which was literally 'pierced' by the wing spar passing through a special square-section sealed tube.

Ilyushin Aviation Complex

An artist's impression of the I-21 (TsKB-32) fighter.

The first prototype was completed in late 1936. Initial test flights showed that the evaporation system did not ensure adequate cooling, both the engine and the wing centre section becoming overheated in flight. Ilyushin saw no point in trying to rectify the faults of the system; further tests were halted. Presumably, the chief designer was well aware of the main drawback of the evaporation cooling system which was extremely vulnerable to combat damage.

The second prototype of the I-21 (in-house designation TsKB-52) was under construction in the second half of 1937; it was fitted with a conventional cooling system and equipped with a retractable radiator. The special feature consisted of the use of ethylene glycol as a cooling agent, which made it possible to reduce the radiator size and the drag generated by it. Nevertheless, the design maximum speed was reduced to 550 km/h (342 mph). The armament comprised two ShVAK cannon. The prototype was not completed due to difficulties associated with the delivery and development of the engine (according to one source, the second prototype was to be powered by the AM-35 engine, which sounds surprising because this engine must have been still on the drawing boards at that time). In 1939 GUAP ordered all work on the fighter to be terminated. It was a very interesting design, but the difficulties of mating a heavy engine with a lightweight airframe proved insurmountable.

Specifications of the I-21 (TsKB-32) fighter (design performance)

Wing span	10 m (32 ft 9¾ in)
Wing area, m^2 (sq ft)	18.16 (195.5)
Length, m (ft)	8.366 (27 ft 5⅜ in)
All-up weight, kg (lb)	2,125 (4,685)
Maximum speed at 3,000 m (9,840 ft), km/h (mph)	598-620 (372-385)
Time to 5,000 m (16,400 ft), min	3.8-4.6
Service ceiling, m (ft)	12,000 (39,360)
Maximum range, km (miles):	
at a speed of 270 km/h (167 mph)	766 (476)
at a speed of 480 km/h (298 mph)	460 (286)
Take-off run, m (ft)	190 (620)

IL-2 attack aircraft

The story of this aircraft destined to become one of the most important elements of the Soviet weaponry during the Second World War began in February 1938 when Sergey Ilyushin came up with a proposal to develop a dedicated ground attack aircraft possessing potent offensive and defensive armament and armour protection. He made his proposal in a letter addressed to the Soviet leaders – Iosif V. Stalin, Vyacheslav M. Molotov and Klim Ye. Voroshilov, as well as to People's Commissar of Aircraft Industry Mikhail M. Kaganovich and Red Army Air Force C-in-C Aleksandr D. Loktionov. Stressing the need for creating an armoured attack aircraft – a 'flying tank', as he termed it, Ilyushin put forward a specific project proposal and asked that he be given an opportunity to design and build this aircraft which, he claimed, could be submitted for State Acceptance trials as early as November 1938. The project was aptly designated LT AM-34FRN (*Le**ta**yushchiy tahnk* – 'flying tank' – with a 12-cylinder Mikulin AM-34FRN engine). Ilyushin's request was granted – he was tasked with designing the proposed attack aircraft. On 5th May 1938 the Government approved the plan for prototype construction in 1938-39 which stipulated that three prototypes of a single-engined two-seat attack aircraft designed by Ilyushin and powered by the AM-34FRN be built by Plant No.39. The first of them was to be submitted for State acceptance trials in December 1938, the second in March 1939 and the third in May 1939 (later the number of prototypes was reduced to two). At the same time the aircraft was redesignated BSh (*broni**rov**annyy shtoormo**vik*** – armoured attack aircraft) and was known for some time as the BSh AM-34FRN. This was a service designation, the in-house designation at the Design Bureau (manufacturer's designation) being TsKB-55. Accordingly, the appellation TsKB-55 AM-34FRN can be found in documents (at that time the engine type was often included into an aircraft's designation).

The reader is reminded that the TsKB prefix inherited by Ilyushin's Design Bureau from the Central Design Bureau was used by Ilyushin for prototype aircraft right up to the outbreak of the Great Patriotic War on 22nd June 1941.

TsKB-55 AM-35 (BSh-2 AM-35) attack aircraft prototype

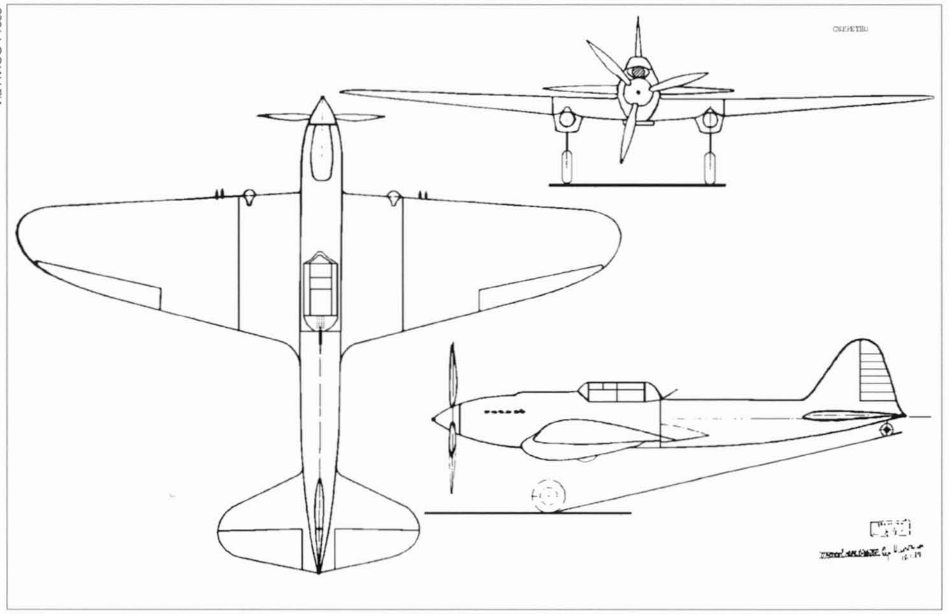
The AM-34FRN engine rated at 960 hp at sea level was ill-suited for the new machine and had been chosen by Ilyushin only for want of a better one; however, it was phased out of production in the meantime. This made it impossible to fulfil the stipulated schedule for prototype construction. Faced with this problem, Ilyushin opted for the new high-altitude Mikulin AM-35 engine for his TsKB-55. It had a take-off rating of 1,350 hp, the nominal rating being 1,130 at S/L and 1,200 hp at the critical altitude of 4,500 m (14,675 ft). The revised specifications for the TsKB-55 AM-35 were endorsed by the Air Force (VVS – *Voyenno-voz**dooshnyye** **see**ly*) chief Aleksandr D. Loktionov on 15th February 1939.

The TsKB-55 was a two-seat cantilever low-wing monoplane with a semi-retractable main undercarriage housed in underwing fairings. Its most distinctive feature was the streamlined fuselage of high-tensile armour steel developed by the All-Union Institute of Aviation Materials (VIAM – *Vseso**yooz**nyy insti**toot** aviatsi**on**nykh materi**ah**lov*) under the guidance of S. Kishkin and N. Skliarov. The armour steel had good impact strength and, most importantly, parts made of it could be stamped into forms having double curvature. This allowed aircraft to be designed with stressed armour skins, whereas the earlier Soviet TSh-1 and TSh-3 attack aircraft had been fitted with strap-on armour.

The TsKB-55's armoured body contained the vital parts: the engine, crew stations (the cockpits of the pilot and the navigator/gunner), fuel and oil systems. The coolant radiator and oil cooler were initially designed to retract into the armoured body in the event of intense anti-aircraft fire and extended to provide normal cooling when the danger was past, but such a system limited the aircraft's time over the battlefield.

A different arrangement was adopted during the design stage. The radiator and oil cooler were installed side-by-side behind the engine in a special duct in the armoured body; the air intake of this sloping duct was

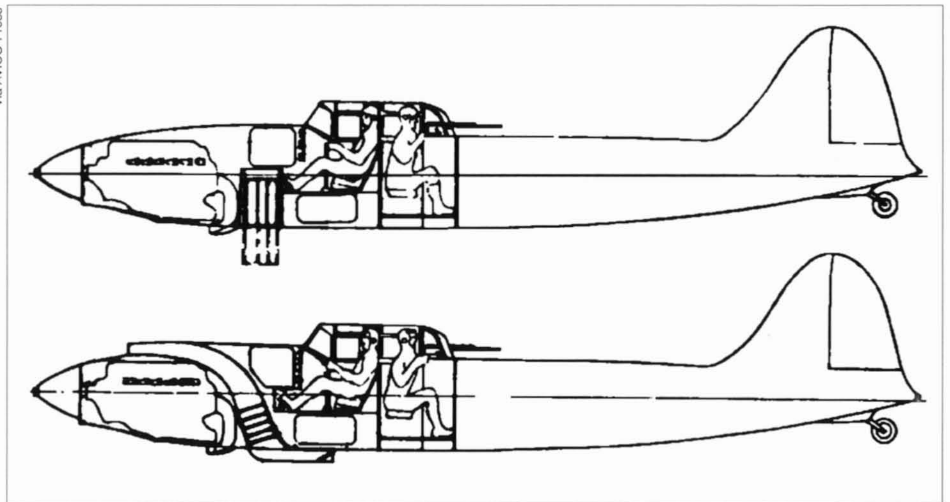
Via AVICO-Press



Ilyushin Aviation Complex

Above: A provisional three-view drawing of the BSh-2 endorsed by Chief Designer Sergey V. Ilyushin on 15th January 1939.

Via AVICO-Press



Ilyushin Aviation Complex

These two diagrams show how the BSh-2 evolved at the design stage. The upper diagram illustrates the original version featuring a semi-retractable water radiator; this was rejected in favour of a buried radiator in a sloping tunnel with a dorsal intake and a ventral outlet as illustrated below.

mounted over the engine cowling, while the air outlet was arranged under the fuselage. This configuration was not quite as effective as the previous one but the aircraft's structure was greatly simplified.

The armoured body was almost entirely included into the primary fuselage structure. It was assembled from stamped sheets of armour of 4 to 8 mm ($^{3}/_{16}$ to $^{5}/_{16}$ in) thickness, a weight reduction being achieved by the optimum distribution of the armour's thickness, taking into account both effective resistance to shell fragments and bullets and the structural loads applied to the armoured body members. Besides, the engineers were aware that at speeds of about 400 km/h (248 mph) the effectiveness of even thin armour panels increased.

The cockpit windshield was made of K-4 bulletproof glass (or, in the Soviet terminology of the time, *transparent armour*). This was the first time this material was used on an attack aircraft produced in the USSR.

Sergey Ilyushin paid great attention to the survivability of unarmoured structural members. For instance, the mainwheels were semi-exposed when retracted, allowing the aircraft to force-land on unprepared surfaces with the gear up, suffering minimum damage to the airframe.

It was originally planned to arm the aircraft with five 7.62-mm (.30 calibre) Shpital'nyy/Komarnitskiy ShKAS machine guns – four in the wings and one on a flexible mount in the rear cockpit. The normal bomb load was 400 kg (880 lb), four 100-kg bombs being housed in bays in the inner wings.

All of these proposals by Ilyushin were accepted. In January 1939 the preliminary design was submitted to the customer and the mock-up was approved. The mock-up review commission's protocol was signed by VVS C-in-C Aleksandr D. Loktionov who also endorsed the new specification, as noted above. On the day following this endorsement, 16th February, the manufacture of two TsKB-55 prototypes started at Plant No.39 (for a while they were also referred to in paperwork as BSh AM-35).

TsKB-55 No.1 (BSh-2 No.1) two-seat attack aircraft prototype

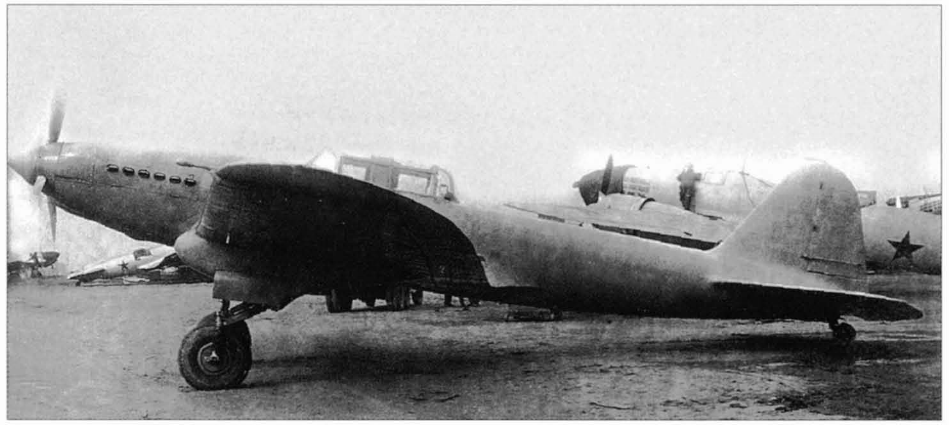
The two TsKB-55 prototypes were of mixed construction, with wooden rear fuselages and fins, all-metal wings and horizontal tails, and fabric-covered control surfaces. The first of them (TsKB-55 No.1) was completed by early July 1939, but it was not until 2nd October 1939 that it made its maiden flight with Vladimir K. Kokkinaki at the controls. On 30th December 1939 he took the second prototype (TsKB-55 No.2) into the air.

The manufacturer's flight tests of the two prototypes proved to be a protracted affair.

Ilyushin Aviation Complex

Above: The first prototype BSh-2 (TsKB-55) at the factory airfield of plant No.39 during manufacturer's tests. Note the water radiator/oil cooler intake atop the nose and the carburettor inlet under the wing leading edge.

Ilyushin Aviation Complex



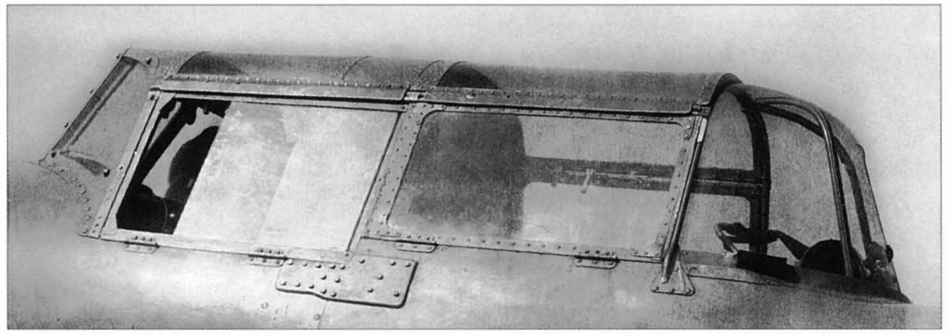
Above: This side view illustrates the BSh-2's cockpit canopy design. Interestingly, the aircraft is totally devoid of markings.

Ilyushin Aviation Complex

Above: A three-quarters rear view of the BSh-2 prototype. Note that the machine-gun turret is completely enclosed; a similar design would be used much later on the IL-10.

Ilyushin Aviation Complex

Front view of the BSh-2 at the factory airfield with brand-new Ilyushin DB-3F bombers in the background. This view shows the lattice-like landing gear design with twin shock absorbers for each mainwheel.



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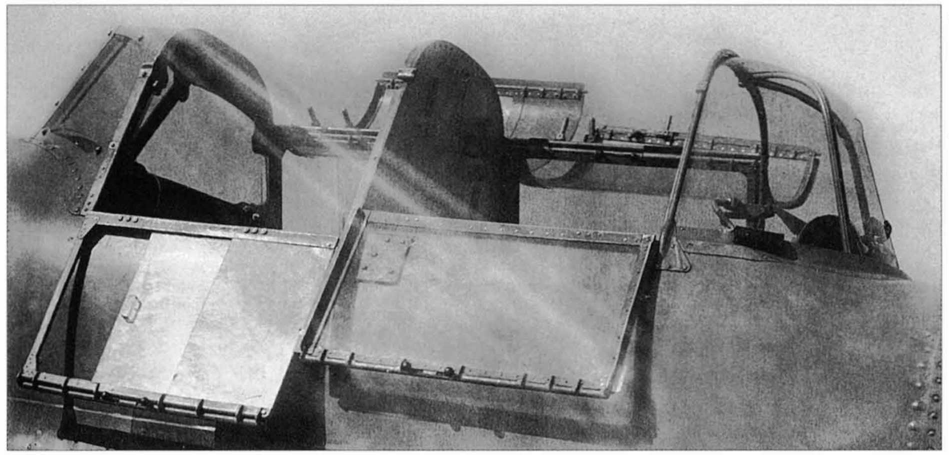

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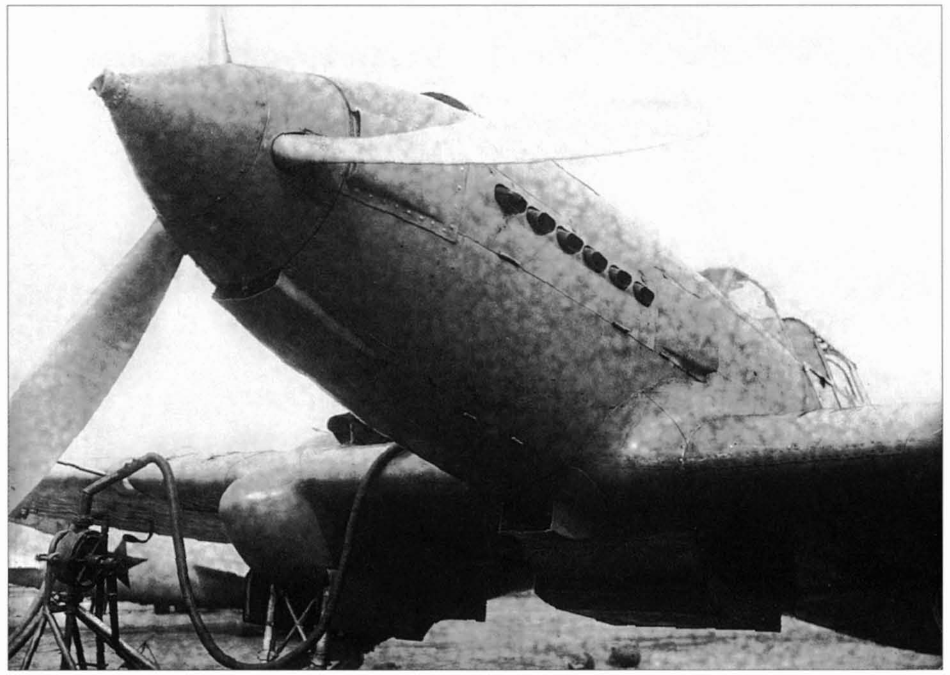
Top and above: The BSh-2's cockpit canopy in closed and open configuration.



Ilyushin Aviation Complex

Close-up of the armoured cowling of the AM-35 engine on the BSh-2. Note the individual short exhaust stubs and the manual petrol pump connected by a hose to the starboard wing.

Difficulties were encountered with achieving proper operation of the water and oil cooling systems, and it took some experimenting before they acquired their final shape. As noted above, the coolant and oil radiators were placed in a duct passing from the top of the engine cowling to the underside of the fuselage. One more version was tested, with the coolant radiator and the oil radiator placed in an armoured bath under the fuselage; it was abandoned in favour of yet another arrangement, in which the coolant radiator remained in the obliquely placed duct within the fuselage, while the oil radiator was transferred to a separate armoured housing under the fuselage. At the same time the original glycol cooling system was supplanted by water cooling.

TsKB-55 No.2 (BSh-2 AM-35) two-seat attack aircraft prototype

Manufacturer's testing was completed on 26th March 1940. A few days later the second prototype was transferred to the Air Force Research Institute (NII VVS – *Nao**och**no-is**sled**ovatel'skiy insti**toot** Vo**yen**-no-voz**doosh**nykh seel*) for its State acceptance trials which lasted from 1st to 19th April and were conducted by project engineer N. Kulikov and pilot Major A. Dolgov, Major I. D. Sokolov acting as test navigator. It was after the completion of these trials that the designation BSh-2 AM-35 (with the 2 digit) was officially adopted and used in the test report.

The test results were generally positive. The test report said the aircraft could be used as an attack aircraft/short-range bomber, provided its main faults were eliminated. The pilots noted that the BSh-2 was quite easy to fly and similar in handling to the Neman R-10 (KhAI-5) and Sukhoi BB-1 tactical bombers. The general conclusion of the military specialists was favourable. In the opinion of military officials it was necessary to manufacture a batch of AM-35-powered BSh-2s and subject them to service trials in order to investigate tactical performance and develop combat tactics.

Strictly speaking, the abovementioned conclusions tended to understate the shortcomings of the machine which had been revealed in the course of testing and were duly recorded in the test report. The BSh-2 fell short of many of the requirements. The maximum speed of 362 km/h (225 mph) at sea level and range of 618 km (384 miles) were less than stipulated in the specification which called for a speed of 385-400 km/h (240-249 mph) and a range of 700-1,000 km (435-620 miles), while the landing speed and take-off run exceeded the design figures. Manoeuvrability and stability were clearly insufficient, and rate of climb left much to be desired. Cockpit visibility was considered inadequate, owing mainly to the single-engined configuration in which the engine cowling obscured the view ahead and downwards. It was also noted that the AM-35 engine suffered from teething troubles. The latter were caused in no small part by the powerful centrifugal high-altitude supercharger allowing the engine to attain a critical altitude of 14,750 ft (4,500 m), which was completely unnecessary for an attack aircraft flying at low altitude. In low-level flight the supercharger was a considerable drain on the engine's power. In response to a request made by Sergey Ilyushin at the manufacturer's test stage the Mikulin OKB developed the AM-38 engine without waiting for an official order. The new engine had no supercharger and was more powerful than the AM-35 at low altitudes but had the same weight and dimensions. The AM-38 was installed in the first prototype TsKB-55 for flight tests. In addition, the aircraft's structure was modified to eliminate the shortcomings revealed by the official tests. Longitudinal stability was improved by increasing the tailplane area and moving the CG forward.

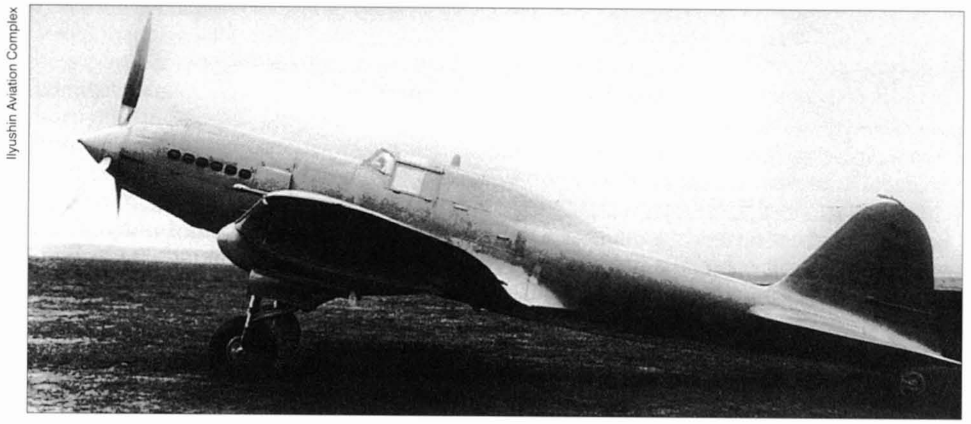
TsKB-57 single-seat attack aircraft prototype

Now we come to one of the crucial points in the development history of the aircraft which later came to be known as the IL-2. It is the transformation of the two-seat BSh-2 into a single-seater. As mentioned above, the two-seat BSh-2 was deemed to be generally acceptable by the military, albeit with some serious reservations. The Technical Council of NII VVS recommended the construction of a batch of 65 aircraft for service trials, but this recommendation was contested by People's Commissar for Defence Marshal Stepan K. Timoshenko who insisted that this batch be reduced to 10 or 15 machines, bearing in mind the serious shortcomings of the aircraft. Accordingly, a resolution issued by the Council of People's Commissars' (the Government's) Defence Committee on 26th June 1940 called for the construction of a batch of ten BSh-2 AM-35s for service tests. However, fulfilment of this order ran into difficulties.

In the meantime, the military increased their pressure on the Design Bureau demanding that the two-seat attack aircraft be urgently modified so as to meet the requirements set out in the official specification. According to the version of events that until recently was generally accepted, it was the military who demanded that the BSh-2 be modified into a single-seater, and Ilyushin, although initially opposed to this, finally agreed, albeit reluctantly. Some researchers, however, are now calling this assertion into question, citing the absence of corroborating documents. In their presentation of events it was Ilyushin himself who came to the conclusion that a mere change of the engine (using the more powerful AM-38 instead of the AM-35) would not solve the problem; additional radical modifications were necessary. He took the decision to turn the machine into a single-seater simultaneously with the installation of the AM-38 engine. This weight-saving measure was accompanied by the installation of a 12-mm (½ in) armoured wall and an additional fuel tank behind the pilot's seat instead of the gunner's cockpit. Thus, the decision to convert the BSh-2 into a single-seater looks like being entirely the Design Bureau's initiative – no official decision on that account

Ilyushin Aviation Complex

Ilyushin Aviation Complex



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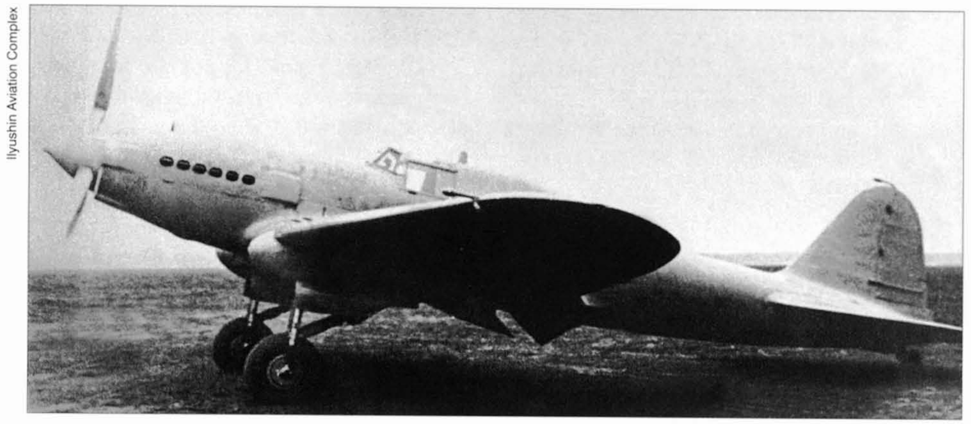

Top, centre and above: The first prototype TsKB-55 was rebuilt to single-seat configuration as the TsKB-57. These views show the long fairing aft of the cockpit. Again the aircraft is devoid of markings.

had been issued by a Government body at that moment. The exact reasons that prompted Ilyushin to take this decision can now only be a subject of guesswork; apparently he came to the conclusion that this was the only way to ensure a speedy introduction of the new machine into series production. Possibly he reckoned with the possibility of reinstating the gunner's cockpit later, when the new AM-38 engine no longer presented any special problems. However, it should be borne in mind that the single-seat attack aircraft concept did, in fact, establish itself rather prominently in the thinking of the Soviet Air Force's leaders. New specifications for armoured ground attack aircraft were drawn up in the light of experience gained during the initial testing of the BSh-2; they called for the development of single-seat machines. In the spring of 1940 they were sent out to the design bureaux headed by Ilyushin, Sukhoi, Kocherigin, Mikoyan and Arkhangel'skiy. It was generally believed at that time that protection of attack aircraft from enemy aerial opposition would be ensured by escort fighters. No one could visualise the real turn of events that happened later…

Upon conversion into a single-seater the TsKB-55 (BSh-2) No.1 was redesignated TsKB-57 – and, judging by the available documents, its existence was officially recognised and endorsed only on the eve of its first flight by an order issued by the People's Commissariat of Aircraft Industry (NKAP – *Na**rod**nyy komissari**aht** aviatsi**on**noy*

promyshlennosti) on 11th October 1940. The order tasked Ilyushin with presenting the modified aircraft for manufacturer's trials on 15th October. Curiously, the order required Ilyushin to present the AM-38-powered BSh-2 No.1 for testing in single-seat and two-seat versions, which was obviously impossible and may be regarded as 'face-saving' ploy on the part of the officialdom.

Be it as it may, the single-seat BSh-2 AM-38 (TsKB-57) made its first flight on 12th October 1940 with Vladimir K. Kokkinaki at the controls. The cockpit canopy had an elongated non-transparent fairing aft of the pilot's seat; the engine was moved forward by 50 mm (2 in), the wings acquired an additional 5° of leading-edge sweepback and the stabiliser area was increased by 3.1%. Thanks to this the centre of gravity was shifted forward from 31% to 29.5% of the mean aerodynamic chord. There were also other less significant changes. The aircraft was to be armed with two 23-mm (.90 calibre) Taubin MP-6 cannon, but these were not yet available and the TsKB-57 retained the four ShKAS machine-guns that had been installed on the preceding version.

During factory tests the aircraft attained a maximum speed of 423 km/h (262 mph) at sea level and 437 km/h (272 mph) at 2,800 m (9,190 ft); its range with a normal bomb load reached 850 km (528 miles). Its handling qualities and airfield performance displayed an improvement on the previous model.

Yet, the TsKB-57 was not presented for State Acceptance trials because of problems with the AM-38 engine which proved to be the IL-2's weak point in its later career. Difficulties encountered with this engine prompted NKAP to issue an order dated 11th December 1940 requiring Plant No.18 in Voronezh to start series production of a single-seat version of the IL-2 (this was the new name of the BSh-2 allocated in accordance with the new system of designations that was introduced in mid-December 1940) with the AM-35A engine instead of the AM-38. The production version was to be based on the second prototype BSh-2 with some changes which, in addition to the AM-35A instead of the AM-35 and the single-seat configuration, included replacing two of the four wing-mounted ShKAS machine-guns with two 23-mm MP-6 cannon.

TsKB-55P – the second prototype single-seat attack aircraft (modified)

In the meantime, the BSh-2 (TsKB-55) No.2 was likewise converted to single-seat configuration. It incorporated a number of improvements intended to remedy the shortcomings revealed previously during the testing of this machine and of the TsKB-57. The modified machine received the factory designation TsKB-55P (the suffix presumably stands for ***push**echnyy* – cannon-armed) and was first flown on 29th December 1940. It differed from the TsKB-57 in some respects. Thus, in an effort to improve the pilot's forward view the engine was lowered by 175 mm (6¾ in) and the pilot's seat and canopy were raised 50 mm (2 in). An armoured glass panel and a short transparent cowl were mounted behind the pilot's head to improve rearward visibility. Thus, the TsKB-55P acquired the characteristic outward appearance of the future production single-seat IL-2. Later, production aircraft of this type earned a nickname *Gor**batyy*** (Hunchback) reflecting the peculiar profile of the cockpit canopy.

Initially the TsKB-55P was intended to retain the AM-35A engine (with which it was actually regarded as a production standard-setter at a certain moment), owing to difficulties with the AM-38 development. However, thanks to some progress in rectifying the faults of the AM-38 engine it was soon found expedient to install it in the TsKB-55P as well. There were further changes as compared to the original configuration of the BSh-2 No.2. To improve longitudinal stability and controllability the engine was moved forward by 50 mm, the wing outer panels received an additional 5° of leading-edge sweep, stabiliser area was increased by 3.1% (the same had been done on the TsKB-57). A new armour shell providing better protection was installed; it featured thicker armour plating, the thickness ranging from 6 to 12 mm (0.23-0.47 in). The place previously occupied by the gunner was now used for installing an additional fuel tank bringing the total fuel load of the aircraft to 470 kg (1,040 lb). The engine was fitted with individual exhaust stubs. The carburettor air intake was transferred to the starboard wing root. A PBP-1b gunsight was installed; it was also suitable for low-altitude bombing. The aircraft was fitted with a gun camera.

IL-2 (IL-2 AM-38) production single-seat attack aircraft.

The manufacturer's tests of the TsKB-55P proceeded at a slower pace than originally planned and were still in progress when NKAP, without waiting for their completion, issued orders placing the single-seat IL-2 with the AM-38 engine into series production at four aircraft plants simultaneously. These were Plant No.18 (Voronezh), No.35 (Smolensk), Nos 380 and 381 (Leningrad). Plant No.18 was designated the 'chief' plant responsible for keeping up the uniform standard of production at all four plants. Appropriate orders were issued by NKAP on 7th January and 14th February 1941. Getting ahead of our story, it can be added that of these plants only Plant No.18 and Plant No.381 succeeded in starting the manufacture of the IL-2 before the outbreak of the war. Later they were joined by Plant No.1 evacuated to Kuibyshev, and by Plant No.30.

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Top and above: Two views of the TsKB-55P, showing the lower-slung engine with five exhaust stubs on each side and the redesigned cockpit with a shorter rear fairing incorporating transparencies to give a measure of rear view. Note the aerial mast and the black/green camouflage to the day's standard.

The latter had actually started gearing up to build the IL-2 before the war, but had to be evacuated before production could get under way. In January 1942 it was returned to Moscow, moving into new premises at the Central Airfield (Moscow-Khodynka), the site of the evacuated Plant No.1; it started manufacturing the IL-2 in February 1942. Plant No.35 had produced only a few examples and was struck off the list, being lost to the Germans after the capture of Smolensk. Plants Nos 380 and 381 were evacuated to Nizhniy Tagil in the Urals and merged into one Plant (No.381) which turned out IL-2s until October 1942 when it switched to manufacturing the Lavochkin La-5 fighter. In January 1942 Plant No.135 in Khar'kov was tooling up to join in the programme of IL-2 production but had to be closed down later that month due to the German offensive and subsequent capture of the city. Thus, Plants Nos 1, 18 and 30 remained the three factories that produced the IL-2 throughout the war. All of them relied on co-operation with subcontractors for the deliveries of armour shells and engines; to some extent the manufacture of wings was also subcontracted out (for example, in January 1942 Plant No.156 in Moscow was tasked with manufacturing wings for the IL-2 and ensuring daily deliveries of six wing sets from March 1942 onwards).

IL-2 AM-38 single-seat attack aircraft with Taubin MP-6 cannon.

The production version of the IL-2 was to be armed with two MP-6 cannon and two ShKAS machine guns supplemented by eight launch rails for 132-mm (5.19-in) RS-132 rocket projectiles. However, fitting the MP-6 cannon to the IL-2 proved to be beset with problems and delays. Ilyushin showed a marked reluctance to install this weapon in his aircraft. He raised objections, pointing out that the MP-6's excessive recoil force was more than double the figure promised by the designer (Yakov Taubin) and far in excess of the design stress limit of the wing structure. In actual fact, it is more likely that he was guided by other considerations, namely his mistrust of the ability of the Taubin design bureau to produce a reliable and trouble-free weapon. Nevertheless, after some pressure from the top brass of NKAP, Taubin's cannon with 81-round ammunition boxes were installed in the IL-2 AM-38 prototype (the TsKB-55P). The installation proved faulty in many respects and required much development work; in particular, it was found necessary to provide the cannon with belt feed instead of ammunition boxes. In the meantime, the prototype IL-2 was equipped with less powerful 20-mm (.78 calibre) Shpital'nyy/Vladimirov ShVAK

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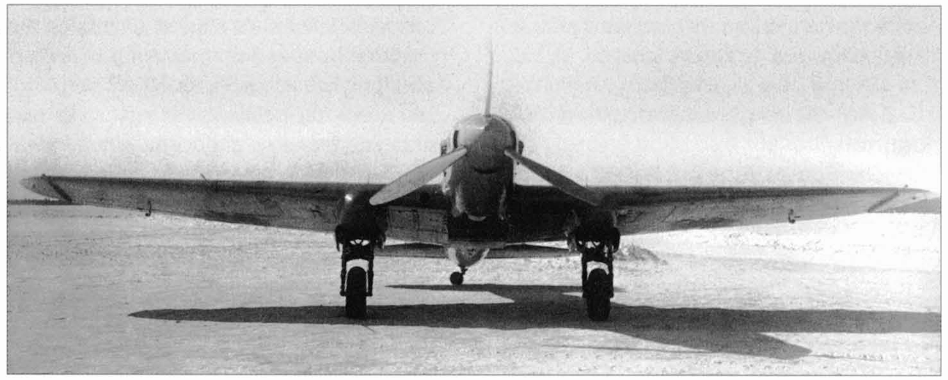

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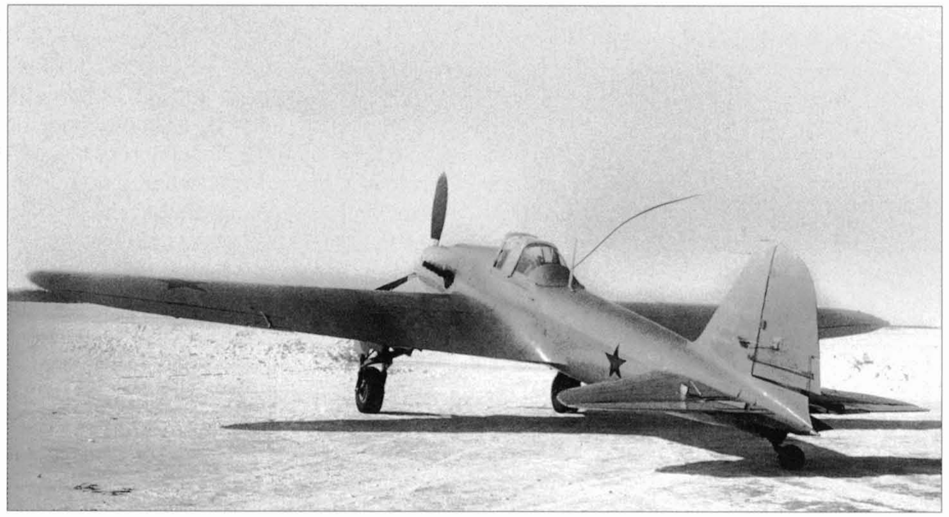

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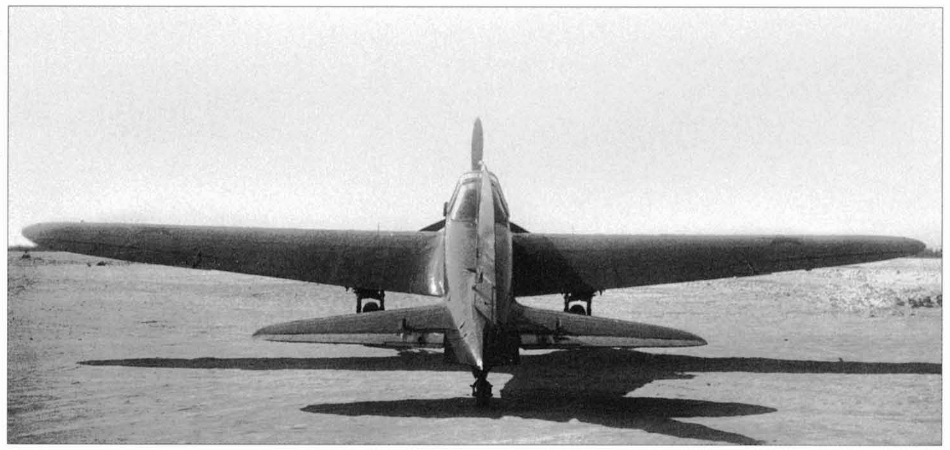

Four views of a pre-production IL-2 at NII VVS during State acceptance trials. Note the deeper intake for the water radiator, the test equipment sensors on the tail recording rudder and elevator deflection, the uniform green camouflage and the old-style star insignia on the fuselage.

cannon and in this configuration it successfully completed its factory tests.

IL-2 AM-38 single-seater with ShVAK cannon

On 27th February the IL-2 AM-38, after having some minor modifications, was officially turned over to NII VVS for State Acceptance trials. They lasted from 28th February to 20th March 1941. The tests revealed a general improvement of the aircraft's performance as compared to the original AM-35 powered two-seat version. Thus, top speed at sea level with bombs carried internally was 419 km/h (260 mph) – 57 km/h (35 mph) higher than that of the BSh-2; rate of climb was increased, controllability and manoeuvrability were considerably improved. There was some decrease in range due to the greater all-up weight and higher fuel consumption of the AM-38 engine as compared to the AM-35. However, on the whole the IL-2 AM-38 was assessed as 'fully meeting the requirements posed to a battlefield aircraft, as regards performance and armament'. True, the State commission also noted a number of defects and shortcomings which had to be eliminated. They included, among other things, faults in the functioning of the AM-38 engine and of the oil and fuel systems, insufficient armour protection for the pilot's head, short range and poor quality of radio communication.

Series manufacture of the IL-2s started concurrently with the State Acceptance trials and initially met with great difficulties. Many problems arose in connection with the manufacture of the armoured shells which were in short supply for some time. In mid-January 1941, citing a delay in deliveries of the armour shells, NKAP requested the Air Force command's consent to a suggestion that the first 20 production machines at Plant No.18 be manufactured with forward fuselages made of boiler plate instead of armour steel 'in order to speed up mastering series production'. These machines, NKAP said, could be used for training. At least one such machine (actually, a mock-up) had, indeed, been built at the plant. Extraordinary efforts had to be undertaken to get the production of the IL-2 under way at the plants designated for this purpose. Plant No.18 (the chief plant) achieved the most satisfactory results among them. The first production machines started rolling off the production line at the beginning of March 1941.

On 10th March 1941 Major K. Rykov, head of the factory's flight test facility, flew the first production aircraft. Despite fears that the AM-38, which had entered production recently, might not pass its 50-hour tests, the engine operated reliably under all conditions.

The second Voronezh-built IL-2 was completed by the end of March 1941, and in April the rate of production started growing. Plant No.18 built 74 aircraft in May 1941 and 159 in June.

IL-2 AM-38 single-seater – armament versions

Interestingly, the first four production machines built by Plant No.18 each had its own type of cannon. The first example was armed with modified belt-fed 23-mm MP-6 cannon; the second example had two Volkov/Yartsev VYa-23 cannon of the same calibre. The third production machine was fitted with two 20-mm ShVAK cannon, and the fourth had two SG-23 cannon designed by Salishchev and Galkin. In addition, all production IL-2s retained two ShKAS machine guns. Starting with the fifth production machine, all subsequent IL-2s were initially armed with ShVAK cannon. A special order issued by NKAP on 17th January 1941 tasked the directors of all four plants involved with manufacturing the single-seat IL-2 in a version armed with two ShVAK cannon and two ShKAS machine-guns. It was followed by a Government resolution dated 12th February 1941 which sanctioned the abovementioned armament version, citing the unavailability of the Taubin MP-6 cannon with belt feed (as mentioned above, it was the MP-6 that had been intended for the IL-2 from the outset). The MP-6 was given a chance of come-back in the event of successful development. Concurrently, Ilyushin was tasked with developing and testing the production version of the ShVAK installation within 20 days. Interestingly, according to some documents, delays with the delivery of the MP-6 cannon resulted in a few production examples of the IL-2 being fitted with a quartet of the ShKAS machine-guns (the original BSh-2 armament version).

IL-2 AM-38 single-seater: MP-6 cannon versus VYa-23

The belt-fed version of the MP-6 eventually made its appearance. Comparative testing of the VYa-23 and MP-6 cannon was first conducted, according to one source, on the two TsKB-55 prototypes between 7th January and 22nd February 1941. It was followed by comparative tests of early-production examples of the IL-2 equipped with belt-fed VYa-23s and MP-6s which took place in the period between 21st March and the beginning of May 1941. Both types of cannon showed satisfactory results and displayed no marked advantages over each other. However, the State commission gave its preference to the VYa-23 cannon in view of its more modern and advanced design. A contributing factor was the low production standard and reliability of the series-manufactured MP-6 cannon. As a result, the MP-6 was withdrawn from series production, while the VYa-23 was recommended for service.

Later, the more potent VYa-23 cannon replaced the ShVAK cannon on many production models of the IL-2 and acquitted itself well in combat operations. As for the SG-23 cannon, all work on it was discontinued due to the unsatisfactory results of tests conducted on a Lavochkin/Gorboonov/Goodkov LaGG-3 fighter in April 1941.

There were two basic arrangements of cannon and machine-guns on production IL-2s. In the ShVAK-equipped version produced by Plant No.381, the cannon were placed inboard of the ShKAS machine-guns, while the VYa-armed version and some ShVAK-armed machines featured the reverse arrangement (the cannon were placed outboard of the machine-guns).

At a later stage, in the summer and autumn of 1941, studies were made of yet another armament fit for the IL-2 comprising two 20-mm Berezin B-20 cannon in addition to the usual pair of ShKAS machine guns. Appropriate directives and orders were issued by the State Defence Committee and NKAP in July 1941. Information on the results of this work is not available; there is no evidence of this version having been produced in series.

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An early-production IL-2 AM-38 armed with Volkov/Yartsev VYa cannon and eight RS-82 rockets pictured during trials.

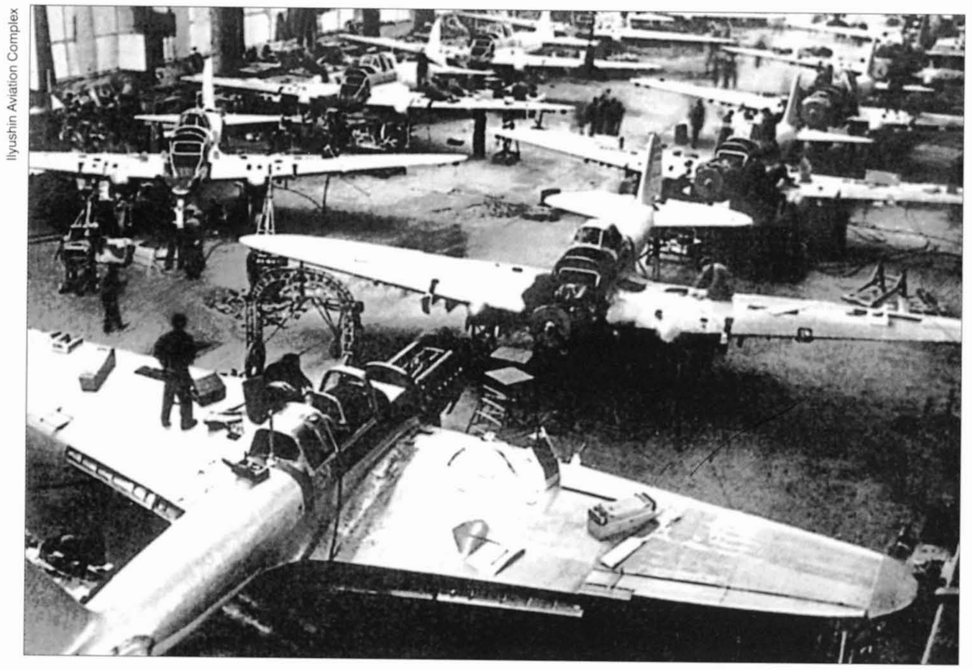
IL-2 – initial combat experience

By the time Nazi Germany invaded the Soviet Union on 22nd June 1941 only 18 IL-2s had been delivered to the units of the Soviet Union's western military districts; worse, they had arrived in crates, and none of them had been flown on site and mastered by the pilots (266 IL-2s had been built in the first half of 1941, but they were mostly assigned to training units and research institutions). Thus, not a single IL-2 engaged in combat with Luftwaffe aircraft on the first day of the Great Patriotic War. The IL-2s received their baptism of fire on 27th June 1941 at the Western front when a group of five IL-2s made a strafing attack against German tanks and infantry columns in the vicinity of Bobruisk, Belorussia.

The first air battles subjected the aircraft to a severe test in the course of which both its strong points and weaknesses came to the fore. Ilyushin's OKB and the production plants were faced with the task of rectifying the aircraft's many shortcomings resulting both from faulty design of some units and equipment items and from poor production standards. Thus, the ShVAK cannon proved to be capricious, jamming after a few rounds had been fired; much effort had to be put in to bring the weapon to a more or less acceptable reliability level. Combat experience also showed deficiencies in the armour protection: early batches of the IL-2 lacked armour plating above the pilot's head, over the engine and the aft fuel tank. It had been presumed that fighter attacks from above would be a rare occasion, but reality turned out to be different. Complaints were made about the insufficient fuel load which severely limited the aircraft's combat radius. The struts of the retractable undercarriage proved to lack the necessary strength which resulted in numerous breakdowns and even crashes. Poor quality of the armour-glass windshield limited the forward visibility for the pilot; this was further compounded by the spraying of the windshield by oil spilled from the propeller hub and the front end of the crankshaft. The PBP-1b reflector gunsight installed on the IL-2 caused discontent because it posed a danger for the pilot in the event of a forced landing: many pilots received serious injuries, hitting their heads against the gunsight. In response to wishes expressed by pilots a new simple mechanical gunsight – the VV-1 – was introduced in early 1942; it comprised a bead placed in front of the cockpit and sighting lines marked on the bulletproof glass windshield. These simple mechanical devices could not ensure high accuracy, and eventually the PBP-1b gunsight made a 'comeback' on the IL-2, albeit in a modified form – it was made easily detachable, enabling the pilot to remove it prior to an emergency landing.

In May and June 1942 aircraft in service were plagued by numerous failures of the AM-38 engines. The cause was traced to dust at unprepared airfields which penetrated into the carburettors and then into the engine cylinders, causing excessive wear of engine parts. Urgent steps were taken to remedy the situation. A special dust filter mounted on the carburettor air intake was quickly developed and introduced on all production machines. It was housed in a thimble-shaped fairing on the starboard wing leading edge near the root; the fairing incorporated a forward opening with eyelid shutters permitting straight-through air flow in flight when the filter was not necessary.

The IL-2 quickly proved its worth, and deliveries of this aircraft to front-line units in large numbers became a matter of high priority. In the weeks following the outbreak of the war the IL-2's daily production rate at the Voronezh plant was 10 to 12 aircraft. This could have been higher, but Plant No.18 was still tasked with building the Yermolayev Yer-2 bomber at the same time. The main problem at the end of 1941 was the drop in



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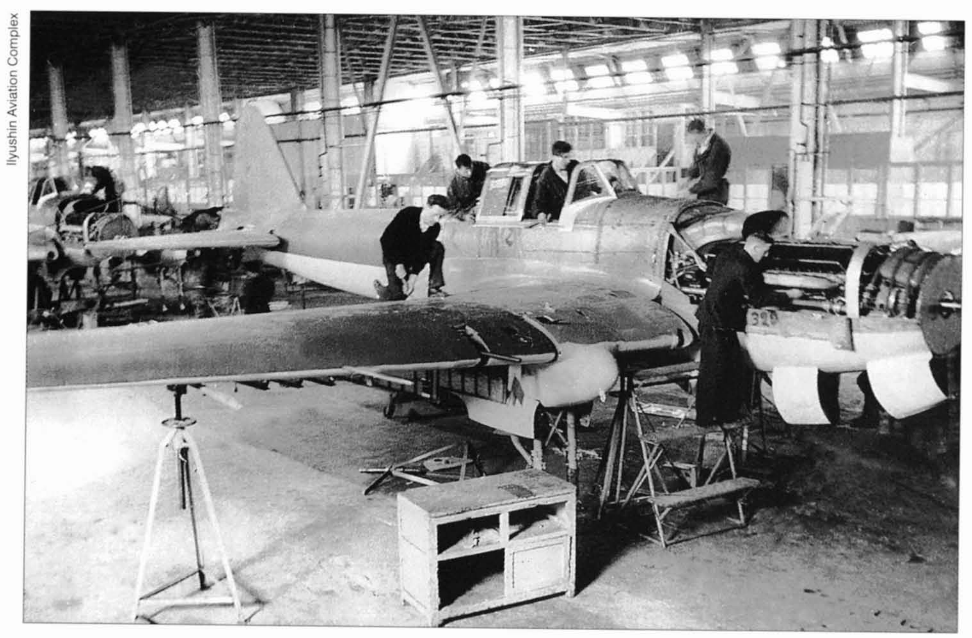

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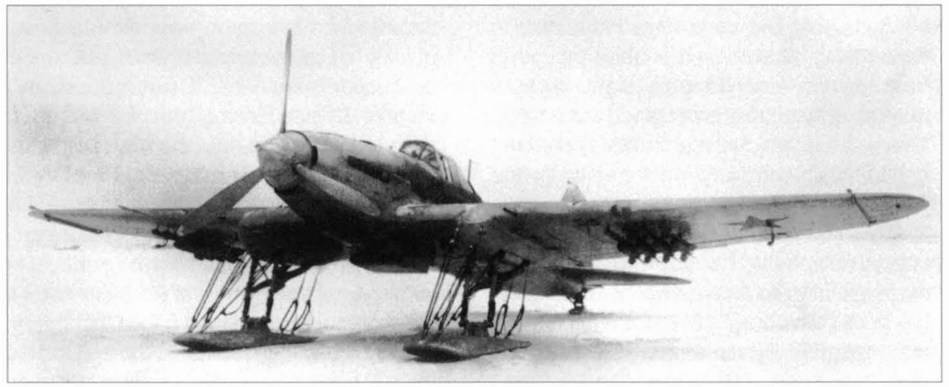
Top and above: Single-seat IL-2s on the final assembly line.



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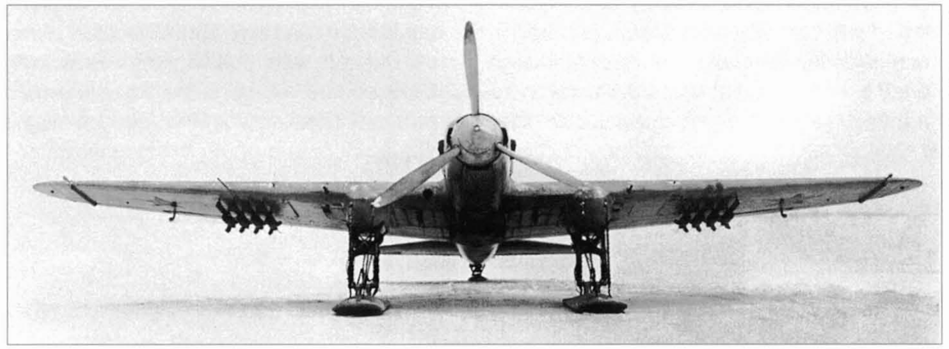

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Top and above: This winter-camouflaged IL-2 AM-38 armed with ShVAK cannons and RS-82 rockets is equipped with non-retractable skis. It is seen here during State acceptance trials in January 1942.

production rates owing to the evacuation of the factories. In late October 1941 production at Plant No.18 temporarily ceased because the plant had to be evacuated. After moving to Kuibyshev (now Samara) the Voronezh plant did not deliver a single aircraft for 35 days. Meanwhile, IL-2 production had just begun at Plant No.1 in Kuibyshev and No.381 that had been evacuated to Nizhniy Tagil in the Urals, but the few aircraft assembled there could not save the day.

IL-2 production – problems and achievements

Production of the IL-2 attack aircraft at the new location had to be organised in harsh conditions, the personnel working in unheated shops which still lacked roofs. The plants suffered an acute shortage of skilled labour and had to recruit new labour force from the local population, including many women and youngsters with no experience of factory work. The difficulties were compounded by housing problems and food shortages bordering on hunger. It was then that Shenkman and Tretyakov, the directors of the plants, received a telegram reading as follows:

'You have let down our country and our Red Army. You have the nerve not to manufacture IL-2s until now. Our Red Army now needs IL-2 aircraft like the air it breathes, like the bread it eats. Shenkman produces one IL-2 a day and Tretyakov builds one or two MiG-3s daily. It is a mockery of the country and the Red Army. [...] I ask you not to try the government's patience, and demand that you manufacture more ILs. This is my final warning. Stalin.'

The words *'We need the IL-2s... like air, like bread'* became the motto of the aircraft industry. Extra efforts were made to complete the assembly shops and organise the delivery of components and materials sourced elsewhere. As a result, by the end of January 1942 the leading IL-2 manufacturer, Plant No.18, had a daily output of seven aircraft. In February the newly-established Plant No.30 in Moscow launched IL-2 production, and in March Plant No.1 was turning out three aircraft per day.

The difficulties experienced by the relocated factories were compounded by the fact that initially they lacked the necessary airfield facilities for pre-delivery and acceptance testing. As a temporary measure, a decision was taken to disassemble the finished aircraft and send them by railroad to Moscow where they were to be reassembled and flown. An order to this effect was issued by NKAP on 2nd January 1942; it stipulated that plants Nos 1, 18 and 381 send their production by rail to factories Nos 165 and 23 in Moscow for reassembly and acceptance by the Air Force representatives (factory No.165 was set up specially for this purpose at the site of the evacuated aircraft factory No.84). Arrangements were also made for the reassembly of the IL-2 aircraft in Voronezh, at the site of the evacuated Plant No.18. This cumbersome procedure entailed much extra work and was discontinued as soon as the evacuated plants had put into operation all the necessary facilities.

IL-2 AM-38 single-seater – landing gear versions

In late July – early August 1941 the Ilyushin OKB had been evacuated from Moscow to Plant No.381 at Nizhniy Tagil (the evacuation order was issued by NKAP on 27th July 1941). One of the chief designer's last tasks before leaving the city was to devise measures enabling the IL-2 to operate from snow-covered airfields. As a stop-gap measure, non-retractable skis were fitted to the IL-2s both by front-line units and at production plants. This version was subjected to State Acceptance trials in January 1942. Non-retractable skis caused a marked drop in speed which was considered unacceptable by the front-line pilots. In response to their demands, a retractable ski landing gear was promptly designed; in flight the skis lay flat against the main gear fairings, minimising drag. The speed was reduced by a mere 10-12 km/h (6.2-7.4 mph). The retractable skis were put into production. The ski undercarriage led to a marked increase in the length of the landing run; and the skis of the parked aircraft had a tendency to freeze to the snow surface. Later, it was decided that packing the snow to achieve a reasonably solid surface was more practical, and the use of skis on the IL-2 was discontinued (no doubt, to a great relief for the production factories which had complained that the fitting of retractable skis was a painstaking job putting the delivery schedule in jeopardy).

Interestingly, there were some highly unorthodox projects with regard to the IL-2's undercarriage. In 1942 an IL-2 version with a caterpillar undercarriage designed by Chechubalin was under development; it was intended to tackle operations from waterlogged dirt strips in the springtime. There is no information as to whether this version was actually built and tested. Even more unusual was a project proposed in July 1941 by engineers Nadiradze and Yefremov. Having successfully tested an air cushion undercarriage on a specially modified Yakovlev UT-2 primary trainer, they proposed fitting a similar undercarriage to the Petlyakov Pe-2 dive bomber – and the IL-2 attack aircraft. This, they claimed, would enable the IL-2 to operate from any unprepared surface (a ploughed field, a swamp) at the expense of some loss in speed. Some preparatory work had been done on the IL-2 version by the two engineers, but apparently the idea was not proceeded with. Conversely, the project was actually put into effect on a single Pe-2 – with disappointing results.

Experiments with the landing gear also included the use of wheel tyres made of solid foam rubber instead of the usual tyres with inflatable inner tubes. The latter, on the IL-2, were notoriously short-lived; still more important was the fact that in the case of one wheel inner tube being pierced by an enemy bullet during a sortie the landing usually ended up in a heavy incident or a crash. One production IL-2 armed with ShVAK cannon was fitted with such modified wheels in August 1941.

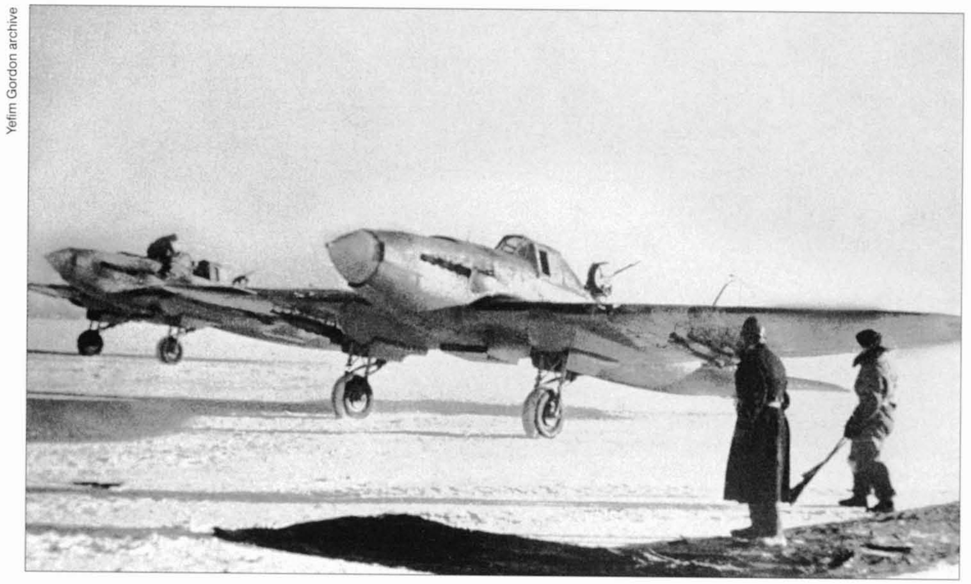
IL-2 AM-38 single-seater – experiments with rear hemisphere defence

Combat experience revealed the IL-2's vulnerability to attack from behind by enemy fighters. From the very first days of the war, front-line pilots realised the necessity for an aft-mounted remote-controlled machine gun, rear-firing rockets or a rear gunner's station, as on the TsKB prototype. In a letter to Stalin, Captain Ye. Koval', a navigator in the 243rd ShAP (*shtoormovoy aviapolk* – Attack Air Regiment), wrote:

'I consider it my duty to demand that the designer and the aircraft industry improve our formidable attack aircraft. Its main shortcoming is that the aircraft is absolutely unprotected against enemy fighters attacking from behind. In most cases the fighter approaches from behind and opens fire at 10 to 15 m (32 to 50 ft), trying to damage the engine or kill the pilot. Compensating for this shortcoming by providing fighter escort does not seem to be effective.'

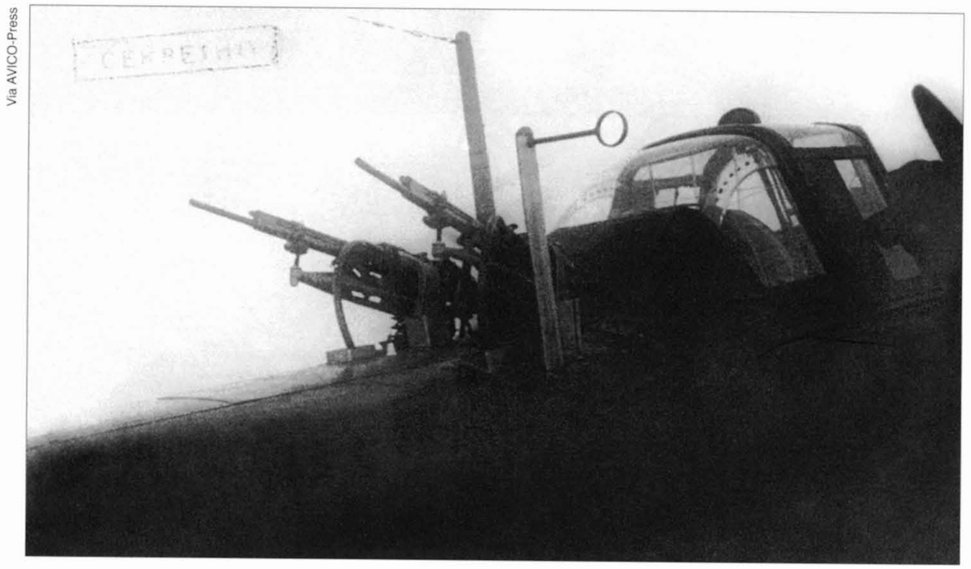
Koval' further wrote that attack aircraft operated at low and extremely low altitudes, while the escorting friendly fighters had to fly at 1,000 to 1,500 m (3,300 to 5,000 ft) over the target and often lost visual contact with their charges. He concluded that a rear gunner was a must.

In an effort to remedy the situation, Ilyushin's OKB developed two types of fixed machine-gun installations intended to protect the IL-2's rear hemisphere. The first of them comprised two fixed rearward-firing ShKAS machine-guns, the other one consisted of one 12.7-mm (.50 calibre) Berezin UBT machine-gun. The machine-guns could move to a certain extent in both cases; aiming was effected with the help of rear-view mirrors. On 28th July 1941 Ilyushin suggested to People's Commissar of Aircraft Industry Aleksey I. Shakhurin that 50 machines be equipped with the fixed machine-gun installation for self-defence. Prototypes of the two versions were to be manufactured and tested in mid-August 1941. After comparative testing the twin-gun installation was found to be more acceptable, yet both of them afforded a low degree of protection and neither was put into production. There were also some field conversions involving the installation of fixed



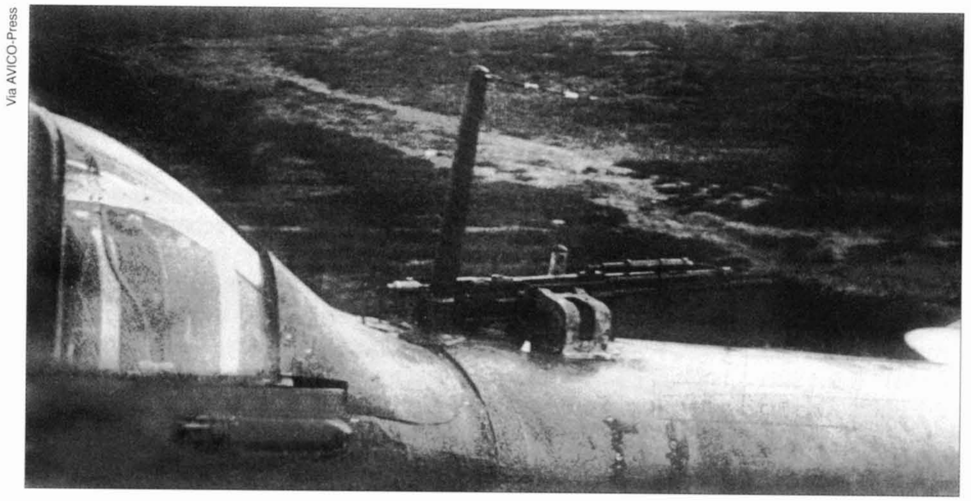
Yefim Gordon archive

Above: When combat experience proved the IL-2's protection against enemy fighters attacking from the rear to be inadequate, service units started incorporating makeshift machine-gun installations to protect the tail. These two IL-2s have been modified in the field, featuring primitive rear cockpits for tail gunners equipped with flexible ShKAS machine guns.



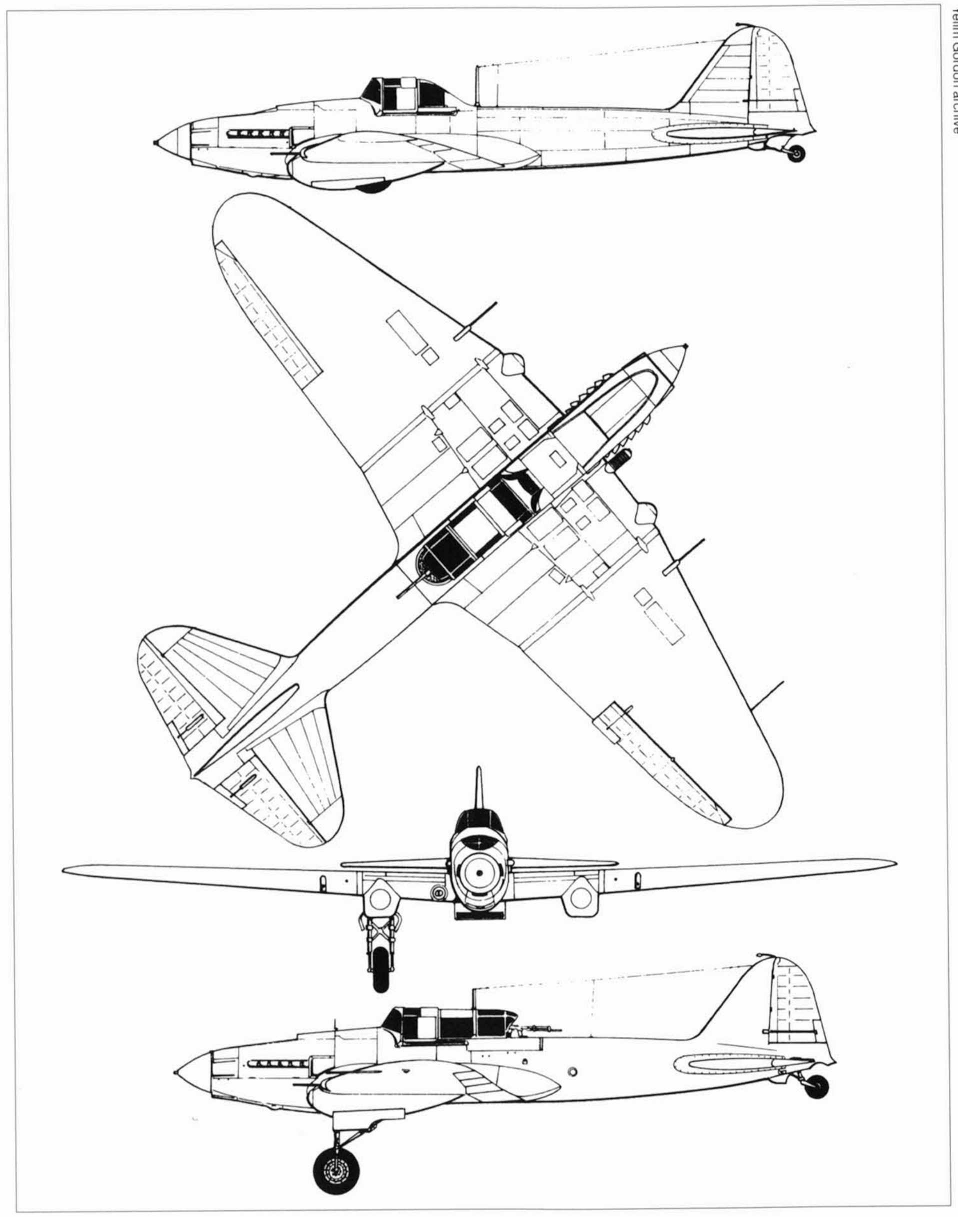
Via AVICO-Press

Above: This twin-ShKAS installation was tested by NII VVS in February 1942 (hence the ink stamp on the photo reading *Sekretno*, 'Classified'). The machine guns were aimed by the pilot, using a periscopic sight!



Via AVICO-Press

Another 'one-man show' configuration. This single-seat IL-2 was armed with a Berezin UB machine gun trained by the pilot and likewise tested by NII VVS in February 1942 to determine the best version.



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A three-view of a typical two-seat IL-2, with an additional side view (top) of the single-seat version.

aft-firing machine guns, but this was not a widespread practice. It was obvious that the rear gunner was indispensible.

IL-2 AM-38 two-seater – field conversions

Without waiting for the OKB and production plants to produce new-build two-seaters, from the spring of 1942 onwards some front-line units started converting IL-2s to a two-seat configuration in the field. Local craftsmen made use of whatever weapon was available: a Degtyaryov DA, Berezin UBT or Shpital'nyy/Komarnitskiy ShKAS machine-gun was placed on an improvised flexible mount (sometimes it was a turret ring taken from the Polikarpov R-5 reconnaissance aircraft or the Pe-2 dive bomber). The 243rd ShAD (*shtoormo**va**ya aviadi**vee**ziya* – Attack Air Division) developed its own variant of such a conversion which was demonstrated to the Air Force command in September 1942. It could be easily effected at the division level and was recommended for widespread introduction. According to some reports, nearly 1,200 machines were modified in the field in this fashion.

IL-2 M-82 two-seat attack aircraft prototype

Ilyushin's first two-seat version of the IL-2 specially designed in response to front-line demands appeared in the process of modifying this aircraft to accept the Shvetsov M-82 nine-cylinder air-cooled radial engine. The primary purpose of this modification was to enable the aircraft to make use of a wider range of engines and provide a back-up in case production of the AM-38 should run into troubles; at the same time the radial engine, which was less sensitive to battle damage, would serve to enhance the aircraft's survivability. It was proposed that, concurrently with the installation of the M-82 with a take-off rating of 1,675 hp, the aircraft be made a two-seater, *'taking combat experience into account'*. The second crew member would ensure protection from attacks from the rear. Ilyushin came up with the proposal for creating this version of the IL-2 in his letter to Shakhurin dated 21st July 1941.

A production IL-2 armed with ShVAK cannon and ShKAS machine-guns was modified to take the new engine. The section of the armoured body up to the front spar, which formed the engine cowling, was removed and a double armoured wall absorbing the loads from the welded engine bearer of the M-82 was installed along the front spar of the wing centre section. The engine was not armour-protected. By making a few changes to the equipment the designer increased the IL-2's fuel capacity to 535 kg (1,180 lb). A gunner's cockpit with a flexible UBT machine gun designed by M. Berezin was provided. The gunner was well protected with armour plating on the sides and the rear wall of the cockpit, as well as above the gunner's head; also, the blister mounting of the UBT machine-gun was provided with bulletproof glazing. The aircraft was designated IL-2 M-82 (in some documents it is called IL-2 M-82A); it was sometimes referred to as the IL-4 (not to be confused with the bomber of the same name).

On 8th September 1941 the new attack aircraft made its first flight at the hands of Vladimir K. Kokkinaki. The manufacturer's tests were quickly completed, showing that at a normal weight of 5,655 kg (12,470 lb) the IL-2 M-82 had a top speed of 382 km/h (237 mph) at sea level and 421 km/h (261 mph) at 2,600 m (8,500 ft). Rate of climb and field performance had deteriorated, but the handling qualities were virtually unchanged. In Sergey Ilyushin's opinion the new two-seat version should lead formations of single-seat IL-2s and protect them from attack by enemy fighters. The new machine passed State Acceptance tests in the period between 4th February and 27th March 1942 and was recommended for series production.

IL-2 M-82IR two-seat attack aircraft prototype

A second prototype of the radial engine-powered IL-2 tested in February and March 1942 was powered by the Shvetsov M-82IR engine (R = *re**dook**tornyy* – geared) with a boost in power rating at low altitudes. It had some armour plating fitted to the underside of the engine cowling. Plans were drawn up to manufacture the IL-2 M-82 at Plant No.381 and Plant No.135, starting in the second quarter of 1942. A total of 678 machines of this version were to be manufactured by the end of the year. However, as early as April 1942 these plans were abandoned because by then the AM-38 engine was well-established in production and the AM-38-powered IL-2 was already mass-produced; the M-82 engine was deemed more urgently required for re-engining the LaGG-3 fighter. It is known that at least one production IL-2 M-82IR was built by Plant No.381 – for some reason, it reverted to a single-seat configuration! Interestingly, in August 1942 Ilyushin made an attempt to reverse the fate of the IL-2 M-82, urging upon Shakhurin the expediency of launching series production of this version; he suggested that it should be renamed IL-6 (this designation had previously been used for the TsKB-60 attack aircraft project; it subsequently applied to a twin-engined bomber described later in this book). At the same time he ventured to provide full armour-plating for the cowling of the M-82. On 3rd September 1942 NKAP issued order No.674s tasking Ilyushin with installing armour protection of the M-82 engine on the IL-2; a prototype of the modified aircraft was to be flight-tested on 10th October 1942. Manufacturing drawings for series production were to be prepared by the same date. Yet, production never materialised.

BSh M-71 project

The IL-2 M-82 was not the only version of the IL-2 to be powered by an air-cooled radial. There was a project of a derivative powered by the more powerful Tumanskiy M-71 engine and bearing the designation BSh M-71. It will be described below together with the IL-8.

IL-2 AM-38 two-seater prototypes

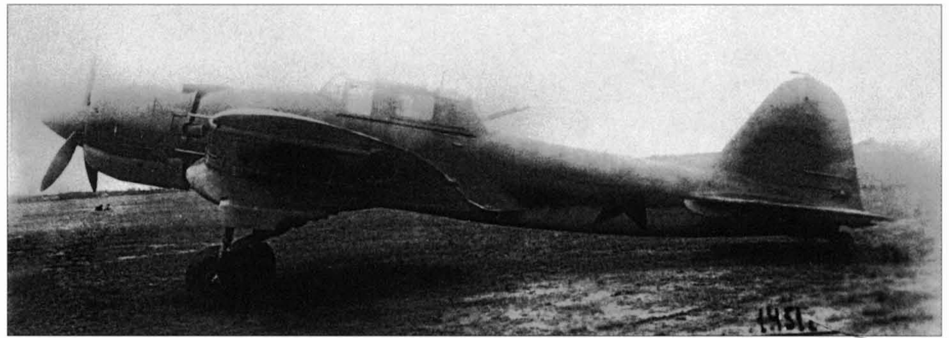
The failure of the two-seat IL-2 M-82 to reach production status made it imperative for the OKB to produce an AM-38-powered two-seat version. By the beginning of September 1942 projects of two such versions had been developed by the OKB. Both of them required minimum changes to the structure and featured a rear cockpit equipped in one case with a ShKAS and with a UBT machine gun in the other case. By the end of September 1942 two suitably modified IL-2s were submitted to NII VVS for comparative State Acceptance trials. They featured a gunner's cockpit placed behind the pilot's seat outside the armour shell. The gunner, facing aft, was accommodated on a belt seat; he was protected by a 6-mm (0.23-in) armour plate from the rear, but otherwise lacked any armour protection. The cockpit canopy hinged open to starboard for entry. The ShKAS and UBT machine-guns were mounted on a semi-turret mount and were belt-fed. The UBT machine-gun could be fired at angles of up to 35° upwards, 35° to starboard and 25° to port. The ShKAS installation had slightly wider angles of fire.

The provision of the second cockpit and extra armament increased the aircraft's AUW. Therefore, to avoid increasing the take-off run unacceptably the flaps were provided with locks allowing them to be set at 17° for take-off. The augmented loads on the tailwheel meant that the wheel had to be enlarged and its attachment point reinforced.

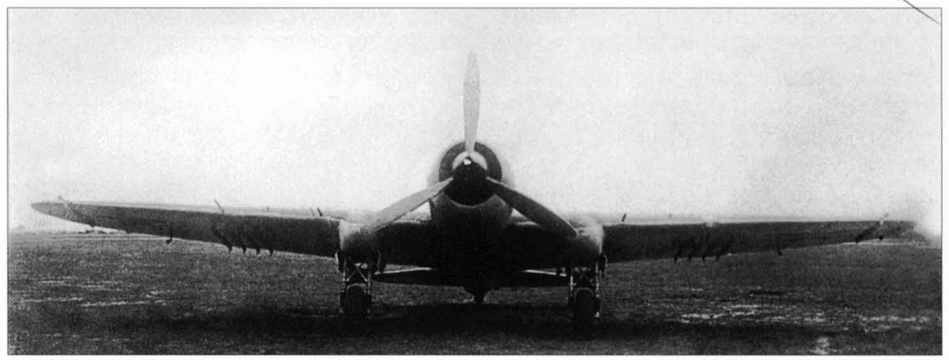
IL-2 AM-38 production two-seat attack aircraft

Both aircraft passed State Acceptance tests the results of which were officially endorsed on 3rd October 1942. Despite its lower performance, it was the UBT-armed version that was recommended for series production. What mattered was the greater firepower of the UBT which afforded a greater degree of protection against enemy fighters. The two-seat IL-2 with the UBT defensive machine-gun was officially ordered into production at plants Nos 1, 18 and 30. It replaced the single-seater as the standard production version and was subsequently manufactured in large quantities. Powered initially by the AM-38 and later by the uprated AM-38F, the two-seat IL-2, like its single-seat predecessor, could be armed with either ShVAK or VYa cannon. The introduction of a gunner on the IL-2 was enthusiastically welcomed by the pilots of attack air units at the front-lines; the UBT proved to be a sufficiently effective defensive weapon on the IL-2. However, the two-seat machine did possess certain weak nesses, first and foremost the lack of adequate armour protection for the gunner.

Ilyushin Aviation Complex



Ilyushin Aviation Complex



Ilyushin Aviation Complex

Top, centre and above: The first prototype of the experimental IL-2 M-82 (c/n ...4714). Apart from the radial engine (a feature meant to increase combat survivability), it reintroduced an aft-facing gunner's station. Note the shape of the cockpit canopy.

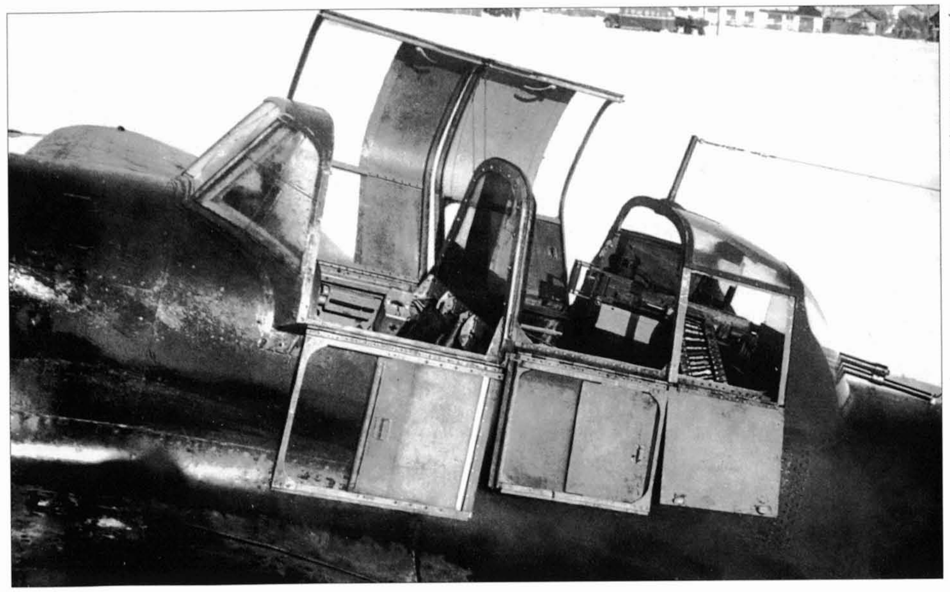
Ilyushin Aviation Complex

Ilyushin Aviation Complex

Ilyushin Aviation Complex

Top, centre and above: The second radial-engined prototype differed in having a geared M-82IR. Note the 82-mm (3.22-in) RS-82 rocket projectiles under the wings.

Ilyushin Aviation Complex



The open cockpit canopy of the second prototype IL-2 M-82 gives details of the defensive machine gun installation.

As for the ShKAS-based version of the rear-mounted machine-gun installation, the effort was not wasted. In October 1942 NKAP sent instructions to production plants Nos 1, 18 and 30 requiring them to manufacture parts that were necessary for installing on the IL-2 a turret ring intended for the ShKAS. These were to be delivered to the Air Force which would use them for converting single-seat IL-2s to a two-seat configuration. In all, 750 shipsets were to be delivered by the three plants in the course of three months (November-December 1942 and January 1943).

In the course of production the two-seat version was subjected to constant improvements and modifications. Most of the resultant variants had no special designations and can be identified only by the numbers of their production batches. In the post-war literature one often encounters the designations 'IL-2M', 'IL-2M3', 'IL-2 type 2' and so on, denoting different variations of the basic two-seat IL-2. However, there is no documentary proof of these designations. Externally noticeable differences between two-seat IL-2s belonging to different production batches included, in particular, variations in the shape of the aft glazing of the gunner's cockpit. It was found to be limiting the movement of the machine-gun; to remedy this, cut-outs were made in the aft part of the rear cockpit canopy. For the same reason the gunner's canopy was sometimes deleted altogether, as can be seen on many wartime photos of the IL-2. The rear cockpit canopy was removed in front-line units to improve visibility for the gunner.

IL-2*bis* two-seat attack aircraft prototype

Several other two-seat models of the IL-2 deserve mention. The first of these was the IL-2*bis* which was developed at Plant No.1 in parallel with the abovementioned ShKAS and UBT-armed versions. The IL-2*bis* (construction number 4434) had a gunner's station with full armour protection and with a blister-type machine-gun mount (called BLUB – ***blis****ternaya oostano****v****ka* ***B****erezina*, Berezin's blister mount) with a UBT; the cockpit was very similar to those of the BSh-2 AM-35 and the IL-2 M-82. The gunner was protected by armour plating from all sides and by a bulletproof glass panel in the rear glazing (blister) where the machine-gun was mounted. To make the gunner's cockpit spacious enough the rear fuselage fuel tank was deleted; instead, two fuel cells of the same total capacity were accommodated in the inboard bomb bays. The aircraft was armed with two ShVAK cannon, two ShKAS machine-guns and eight launch rails for 82-mm unguided rockets. In October 1942 the IL-2*bis* successfully passed its factory tests and State Acceptance trials. These were followed by service trials at the front where the prototype machine made nine sorties before being shot down by ground fire. It won praise from the flying personnel; the gunners were particularly impressed by the roomy rear cockpit affording good protection and ease of operating the weapon. However, this modification required significant structural changes associated with the relocation of fuel tanks, and its internal bomb load was reduced to 200 kg (440 lb) because two inboard bomb bays were unusable. For these reasons this version was not adopted for full-scale production.

IL-2 two-seat prototype with MV-3 turret

A prototype of this version was built in May 1943. The MV-3 turret designed by Mozharovskiy and Venevidov was fitted with a UBT machine-gun and aerodynamically balanced. It had appreciably greater angles of fire compared to other versions of defensive armament, and the aerodynamic balance enabled the gunner to use his weapon at speeds in excess of 400 km/h (249 mph). However, the turret was too bulky and caused a considerable deterioration in the aircraft's performance. Therefore, it was not introduced on production IL-2s.

Experiments with defensive armament on the IL-2

In response to front-line pilots' wishes the semi-turret ring for the UBT machine-gun on the IL-2 was replaced by a VUB-3 turret designed by I. I. Toropov and mounting the same weapon. Its angles of fire were increased to 45° upwards, 35° to either side and 12° downwards.

In 1944 two more versions of defensive armament were tested on the IL-2. One of them was the UBSh defensive installation with a UBT machine-gun possessing a greater ammunition supply (200 rounds) and wider angles of fire. It was found to possess no tangible advantages over the VUB-3 installation already in service, and it was felt that an increase in the firepower of the defensive weapon was called for. Accordingly, an installation with a 20-mm Berezin UB-20 cannon on a standard VUB-3 mount was developed and tested on a production IL-2. The results were satisfactory, yet the installation was not adopted for series production due to the poor reliability record of the cannon itself.

IL-2 – AM-38F-powered versions

Meanwhile, the Ilyushin Design Bureau kept working on improving the IL-2. In the summer of 1942 the OKB resorted to a change of

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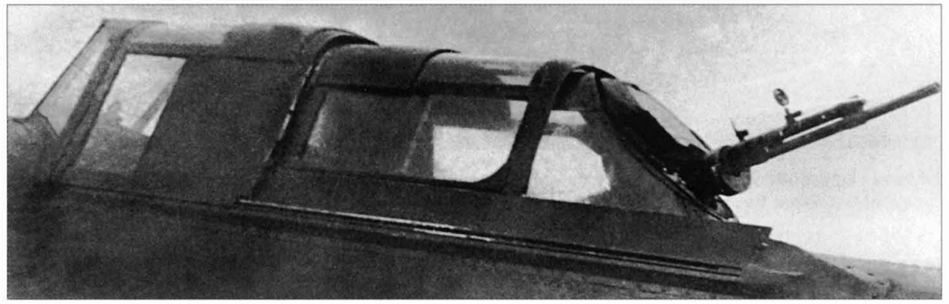
Above: The IL-2*bis*, a refined version of the two-seater featuring a fully enclosed gunner's cockpit, seen at NII VVS during trials. The aircraft wears early-style insignia.

Russian Central National Economy Archive



Above: Close-up of the IL-2*bis*'s streamlined canopy. Note that the gunner also enjoyed the protection of a bulletproof glass panel.

powerplant to enhance the aircraft's performance. A prototype AM-38F (*for****seer****ovannyy* – uprated) engine giving improved performance for take-off and at low altitude was installed in a single-seat IL-2. The new engine provided 1,700 hp (1,268 kW) for take-off and its critical altitude was 2,500 ft (750 m) versus 5,400 ft (1,650 m) for the AM-38. Engine speed was increased from 2,150 to 2,360 rpm and the compression ratio reduced from 6.8 to 6.0, permitting the use of low-octane fuel. The design bureau sought to increase engine reliability by changing the inlet configuration, and the installation of an air filter proved helpful. However, it took some time to eliminate the teething troubles of the new engine. Deliveries of two-seat attack aircraft powered by the uprated AM-38F in January 1943; the new engines were retrofitted to single-seat machines as well. The uprated engine enabled the IL-2 to attain greater speeds and increased the rate of climb at sea level; field performance was also improved and a greater warload could be carried.

IL-2 two-seater powered by the M-250 engine (project)

Concurrently with the work on the AM-38-powered two-seat versions of the IL-2, at the Chief Designer's initiative the Ilyushin OKB started design work on a two-seat IL-2 powered by the Dobrynin M-250 engine. Developed under Vladimir A. Dobrynin's direction by the KB-2 MAI design bureau of the Moscow Aviation Institute, this engine had a take-off rating of 2,270 hp and a nominal rating of 1,900 hp at an altitude of 1,000 m (3,280 ft). Ilyushin was so impressed by the promised performance of the M-250 that he called it 'the engine of the future' and ventured to install it in an IL-2 with a view to speeding up the engine's flight testing and development. The M-250-powered IL-2 was to be armed with two VYa-23 wing-mounted cannon and two 12.7-mm wing-mounted UBK machine guns, a single UBT machine-gun being provided for self-defence. Its normal bomb load was to reach 600 kg (1,320 lb), or 800 kg (1,760 lb) in overload configuration; the maximum speed at sea level and at altitude was to be 450 and 490 km/h (280 and 305 mph) respectively.

So far there is no evidence that this version was actually built. One can actually surmise the opposite, judging by the comments in Ilyushin's report to NKAP on Plant No.240's activities in 1942 (in letter No.14/180s dated 16th February 1943). He stated that design work on installing the M-250 engine on the IL-2 had been started in the second quarter of 1942; however, *'due to unavailability of the M-250 the design work on this installation was suspended and was not resumed in 1942'*. Interestingly, People's Commissar of Aircraft Industry Aleksey I. Shakhurin made the following comment in his letter to Stalin on the prospects of the M-250 engine: *'Installing the M-250 engine in the two-seat IL-2 attack aircraft will entail an increase of its gross weight to 7,000-7,300 kg* [15,430-16,100 lb] *and cause some*

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Above and below: Two more views of the gunner's station. The rear canopy was cut away at the sides to maximise the gun traversing angle. Note that different models of machine-guns are installed.

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centre-of-gravity problems. The mentioned modification of the IL-2 will require an increase in the wing area and larger tail surfaces, as well as a rearrangement of the coolant and oil radiators…' Indeed, it is difficult to visualise the IL-2 retaining its dimensions when fitted with this monster of an engine with 24 cylinders in six radially arranged banks; the engine's dry weight was as high as 1,200 kg (2,650 lb) – a good deal more than the 880 kg (1,940 lb) in the case of the AM-38F.

Powerplant improvements on the IL-2

In an effort to boost the power of the AM-38F engine on the IL-2, Ilyushin's Design bureau resorted to using water injection. In 1944 a suitably modified IL-2 was tested in the NII VVS. The results were satisfactory, but the scheme had one drawback. The water tank, for want of a better accommodation, occupied the place of the gunner, thus depriving the IL-2 of its rear protection. This was characterised as unacceptable both by Ilyushin and by the military, and the project was abandoned.

Another question pertaining to the powerplant was the automation of its control by the pilot. A hydraulic device was developed which automatically adjusted the propeller's pitch to the engine speed, relieving the pilot of the manual adjustment of the pitch. This was the so-called combined throttle-and-pitch control lever developed at the Central Aero Engine Institute (TsIAM – *Tsen**trahl**'nyy insti**toot** aviatsi**on**novo mo**to**rostro**yen**iya*). An example of the IL-2 equipped with this device successfully passed State acceptance trials which had demonstrated a significant improvement in the ease of handling; the most economic flight mode was maintained automatically. On 25th March 1944 the People's Commissariat of Aircraft Industry issued order No.529s tasking the industry with starting series production of the device. In a letter dated 25th July 1944 and addressed to a deputy People's Commissar of the Aircraft Industry Ilyushin advocated introducing this feature on all production IL-2s without prior service trials. However, it is not clear to what extent this recommendation was followed.

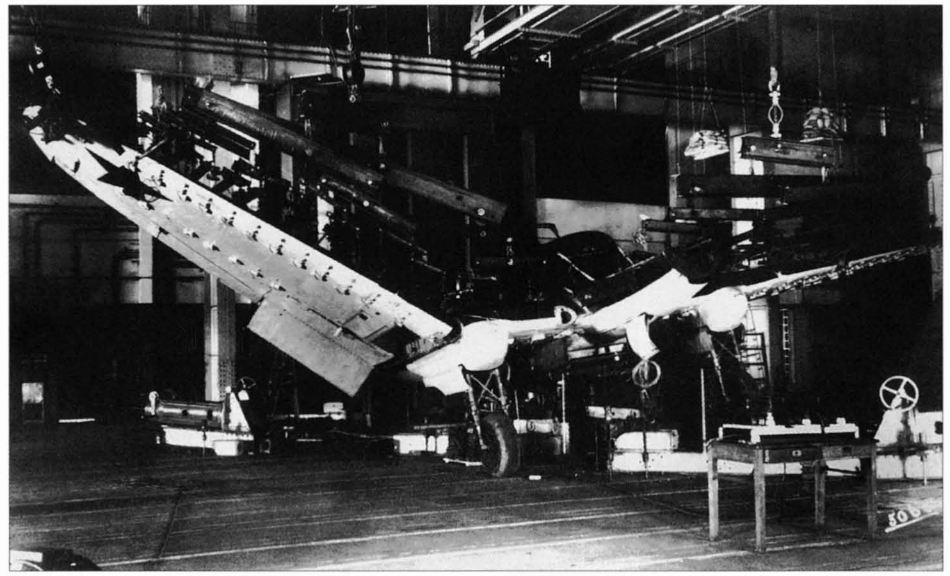
In his quest for improving the performance of the IL-2 as regards speed, range, payload and field performance, Ilyushin attached considerable importance to choosing the propeller type that would make the most efficient use of the available engine power. Several propeller types were used or tested on the IL-2 in the course of its production life. Initial production models were equipped with the VISh-22T three-blade variable-pitch propeller (*vint izmen**yay**emovo **sha**ga*). It had a propensity for leaking oil through the hub which caused Ilyushin to seek alternative propeller types. These were found in the AV-5 series (*avtoma**tich**eskiy vint* – propeller with automatically adjusted pitch). On later aircraft the VISh-22T was successively replaced by new propellers, first by the AV-5L-124 and then the AV-5L-158, both of them also having three blades. The introduction of new propellers was, in particular, associated with the switch-over to the boosted AM-38F engine. The AV-5L-124 propeller was tested on an IL-2 at Plant No.30 between 20th and 24th May 1942 (according to an NKAP order issued on 24th May) and was later fitted to some production machines. It was, however, regarded as an interim solution pending the availability of the AV-5L-158 propeller, transition to which was strongly urged by Ilyushin. This propeller had a diameter of 3.6 m (11ft 9½ in) and a blade width of 292 mm (11½ in), respective figures for the AV-5L-124 being 3.4 m (11 ft 2 in) and 260 mm (10¼ in). On 31st July 1942 a prototype propeller of this type was tested on a production IL-2 c/n 182412 (that is, plant No.18, Batch 24, 12th aircraft in the batch) powered by a prototype AM-38F engine; the testing was conducted by NII VVS. According to 'preliminary conclusions', the AV-5L-158 propeller did not offer any substantial advantages over the AV-5L-124. However, at the end of August Ilyushin wrote to Shakhurin, reporting the successful testing of an IL-2 with the boosted AM-38 engine and the AV-5L-158 propeller; he stressed the fact that the new engine/propeller combination ensured a reduction of the take-off run from 550 to 370 m (1,800 to 1,214 ft), that is by 32%. He urged immediate steps to introduce both the new engine version and the new propeller on the production lines. A little later a fly-off was arranged between an IL-2 equipped with the AV-5L-158 propeller and landing flaps and an IL-2 with the AV-5L-124 propeller and no landing flaps. Both were two-seat machines with the UBT machine gun in the defensive position. The results were convincingly in favour of the former of the two machines, and on 5th October 1942 the State Committee for Defence issued a resolution ordering the two-seat IL-2 with the AV-5L-158 propeller, AM-38 engine, landing flaps and the UBT defensive machine gun into series production instead of the single-seat IL-2.

In May 1942 Plant No.30 was, among other things, tasked with testing the new VISh-105 propeller on the IL-2. This propeller was not adopted for production IL-2s.

In 1943 one production IL-2 was experimentally fitted with an AV-9L-158 four-blade variable-pitch metal propeller. It was tested at the NKAP's Flight Research Institute (LII – *Lyotno-is**sled**ovatel'skiy insti**toot***); the new propeller afforded a modest reduction of the take-off run and virtually no increase in horizontal speed as compared to the standard version with the AV-5L-158 three-blade propeller. On the minus side, the four-blade propeller had a tendency to overspeeding when the throttle was pushed forward at take-off or in level flight. In consequence, the AV-9L-158 was deemed unsuitable for series manufacture, and four-blade propellers were never seen on production IL-2s.

IL-2 AM-38F production two-seater – airframe modifications

In the course of series production the IL-2's airframe underwent a number of modifications with a view to improving the aircraft's aerodynamics, increasing its structural strength and enhancing combat survivability. These modifications, in particular, were applied to the wings. The introduction of the gunner's station led to a rearward CG shift by approximately 3.5% mean aerodynamic chord (MAC) which caused a worsening of the aircraft's static longitudinal stability. To remedy the situation, the CG was moved forward again by increasing the sweepback of the outer wing panels to 15° (that is, an increase of 6°). As a result, the CG position moved from 31.5-32% MAC to 28% MAC. Better longitudinal stability led to an improvement of the IL-2's combat qualities, ensuring more accurate aiming when firing the guns or performing a bombing attack. Ilyushin proposed this modification to NKAP in May 1943. An AM-38F-powered IL-2 produced by Plant 18 (c/n 186767) and featuring the new wings, together with other aerodynamic refinements, passed testing at NII VVS between 20th September and 9th October 1943. Production of the IL-2 with increased-sweep outer wings began in late 1943.



TsAGI

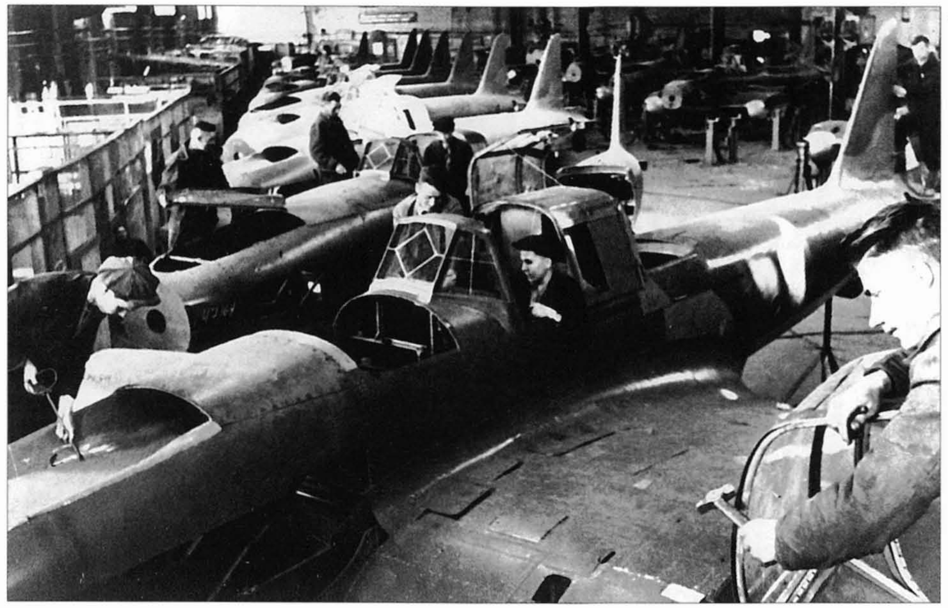
The starboard wing of an IL-2 fails as the ultimate load is reached during static tests.

Initially, the new outer wing panels were produced in both wooden (or mixed-construction) and all-metal versions. An example of the former is a Moscow-built IL-2 (c/n 303316 – that is, plant No.30, Batch 33, 16th aircraft in the batch) with wooden wings featuring increased sweepback; it was tested in May 1944. However, Ilyushin insisted from the outset that preference should be given to the metal construction, which increased the aircraft's ability to absorb combat damage and made it more suitable for repairs. It also afforded a weight saving of 100 kg (220 lb) as compared to the mixed construction, and required fewer man-hours in manufacture. Production of metal wings was started at Plant No.18; in January 1944 Ilyushin together with the top leaders of the aircraft industry and Air Force representatives wrote a letter to Stalin, suggesting that the other two production plants (Nos 1 and 30) also switch to manufacturing IL-2s with metal wings, while the wooden wings be relinquished altogether. Accordingly, on 18th January the State Defence Committee issued resolution No.4976ss which stipulated that the three aircraft plants should completely switch to the manufacture of metal wings with increased sweepback by the summer of 1944 (Plant No.18 by 15th April, Plants Nos 1 and 30 by 15th May). This was to be achieved without reducing the overall output of the IL-2s. Additionally, on 21st February 1944 NKAP tasked Plant No.64 in Voronezh with manufacturing metal wings of the new type for the IL-2.

The question of vulnerability to combat damage, understandably, was of utmost importance for the service units. The IL-2's survivability was appraised in the 1st ShAK (*shtoormo**voy** avia**kor**poos* – Attack Air Corps), and Ilyushin's predictions were confirmed. As a rule, the lower armour could not be pierced by small-calibre projectiles, and the cockpit also turned out to be well protected. Experience showed that the armour shell provided adequate protection against 7.62-mm bullets, while the 20-mm high-explosive ammunition of the German flak and heavy machine-gun bullets could pierce the armour and inflict serious damage. The IL-2s suffered heavy losses both from enemy

Ilyushin Aviation Complex

The prototype of the two-seat IL-2 pictured during State acceptance trials in 1942. Unlike later production aircraft, this one had a ShKAS machine gun in the rear cockpit. Note the short aerial mast and the vertically cut-off rear end of the gunner's glazing.



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Two-seat IL-2s take shape at one of the factories. Note the lozenge-shaped reference lines on the bulletproof windshield which were part of a makeshift gunsight. The second aircraft in the row is c/n 47169.

fighter attacks and from ground fire. Nevertheless, there were many examples showing the aircraft's ability to take an awful lot of punishment and return to base with what might well be termed as 'fatal injuries' to the airframe. One pilot managed to land his IL-2 with the rudder and the port tailplane shot away by anti-aircraft fire; another landed with the wing centre section skin and flaps completely gone.

The rear fuselage, outer wing panels and oil cooler suffered most from AA fire. The use of non-strategic materials when metal became scarce created problems in this respect. A matter of concern was the wooden rear fuselage which had been standardised on the majority of production IL-2s (in May 1941 Plant No.18 was authorised to manufacture 200 IL-2s with metal rear fuselages due to temporary problems with wood supplies). The strength of the wooden tail was clearly insufficient to sustain heavy battle damage. Sometimes the rear fuselage failed in flight. Equally vulnerable were the wooden wings. There were cases when the plywood skin of the wings broke away. Experience showed that IL-2s with metal outer wing panels had better chances of survival. When deliveries of metal to the aircraft factories became regular, all-metal wings were introduced (as noted above) and the rear fuselage structure was reinforced with angle extrusions (these had already been used on single-seat IL-2s earlier). These features were incorporated in IL-2s manufactured in the second half of 1944.

In April 1994 the Air Force approached the NKAP with a request for switching to all-metal IL-2 airframes, but this wish was granted. On 14th May 1944 People's Commissar of Aircraft Industry A. I.Shakhurin wrote thus to N. Seleznyov, a senior Air Force official: *'In response to your letter on series production of the IL-2 with metal rear fuselages at Plants Nos 1, 18 and 30 I inform you of the following: NKAP intends to switch Plant No.18 to manufacturing the all-metal IL-8 AM-42 aircraft in 1944, and plants Nos 1 and 30 [to IL-8 production] in 1945. Bearing this in mind, NKAP considers it inexpedient to switch plants Nos.1 and 30 to production of the IL-2 with metal rear fuselages because this will require much rigging and tooling, while the workshops need to be tooling up for the production of the all-metal IL-8'* (this aircraft, which lost out to the IL-10 in production, is described later in the book). In actual fact, one may surmise that the top echelon of NKAP was simply reluctant to introduce major changes into the well-established production processes. At a later stage (after the war), complete metal rear fuselages were manufactured to replace the wooden ones.

In the spring of 1944 Ilyushin's OKB resorted to modifying the armour shell of the aircraft, extending it to aft to include the gunner's cockpit. This was done with a view to enhancing the IL-2's survivability and ensuring better protection for the gunner. A Moscow-built IL-2 (c/n 305395) featuring the extended armour successfully passed State acceptance tests on 25th August 1944. The all-up-weight was increased by 30 kg (66 lb), the bomb load of 400 kg (880 lb) remained unchanged. Concurrently, the OKB developed a 'repair kit' of additional armour plating to be retrofitted to IL-2s in the field. These measures were received with enthusiasm by the flying personnel of the attack air units, but their implementation was not as speedy as one might have wished. The repair kits reached the service units with unpardonable delays. As for the extended-armour version, no immediate decision about its series production was taken, despite insistence on the part of the Air Force. In November 1944 Aleksey I. Shakhurin proposed in a letter to Gheorgiy M. Malenkov that IL-2s with the extended armour shell be placed in production at Plant No.30, while Plants Nos 1 and 18 were to stick to the previous standard. It was not before the spring of 1945 that Plants Nos.1 and 30 started series production of the new version which, in consequence, reached the Air Force units mostly after the end of the war (593 machines of this type had been produced by the two plants by the end of 1945).

IL-2 AM-38F production two-seater – improvements to controls etc

A series of measures designed to enhance the performance and combat efficiency of the IL-2 included some modifications to the control system. For example, counterweights were installed in the elevator control circuit, making it easier to lift the two-seater's tail during take-off and improving longitudinal stability. In July 1943, at the initiative of TsAGI, experiments were conducted by LII to study the influence of horn balances on the elevators on longitudinal stability and controllability of the IL-2. It was established that the introduction of this feature virtually did not affect the aircraft's stability and handling. Among the measures intended to enhance the combat survivability of mention must be made of the introduction of duplicate elevator control linkages – something that was requested by front-line pilots who cited many cases of their mounts crashing after the control rods had been severed by enemy bullets. As early as August 1941 Director of Plant 18 Shenkman and chief of the plant's design section Nazarenko raised the question of introducing duplicate cable linkages instead of elevator control rods. Having obtained approval from Ilyushin, they tested the new control linkages on an IL-2. The tests were successful, and the new feature was recommended for introduction on production machines; yet, this recommendation was not put into effect at that time. Surprisingly, Ilyushin had come to the conclusion that the danger of control linkage failure due to combat damage was exaggerated. However, the short supply of tubes required for control rods prompted Shenkman to raise this question again in January 1942, and this time Ilyushin gave his consent to incorporating the duplicate cable linkages on production machines. This, however, was not the end of the story. Obviously, in actual fact the majority, if not all of the IL-2s went on to be manufactured

without the duplicate control linkages. Sometimes these were installed in the field by the technical personnel of front-line units. Such was the case in the 18th ShAP of the Black Sea Fleet Air Arm, where several IL-2s were modified in this manner in December 1941. Only from mid-1943 onwards did the factory-produced version of duplicate control linkages find its way to the IL-2. Between 20th September and 12th October 1943 IL-2 c/n 186767 fitted with duplicate control linkages was undergoing State checkout trials. There is evidence that Ilyushin's OKB was still dealing with developing the duplicate elevator controls as late as mid-1944 when a two-seat AM-38F-powered IL-2 was fitted with such controls.

The aircraft's fuel system was also subjected to certain modifications. In the spring of 1943 the combat survivability of the IL-2 was further enhanced through the introduction of self-sealing fuel tanks made of fibre. In contrast to metal tanks, the holes produced by bullets in the fibre tanks did not have lacerated edges; this speeded up the process of the protective layer sealing the hole. A batch of 100 IL-2s with fibre fuel tanks produced by Plant No.18 was sent to front-line units for service trials which began in August 1943.

In 1943, when the Red Army mounted successful offensive operations and was rapidly advancing, the inadequate range of the IL-2 became a more acute problem. Its solution was sought through the use of drop tanks. Several types of such tanks were developed and tested. They included the PTB metal drop tanks (*podves**noy top**livnyy bahk*) holding 175 litres (38.5 Imp gal), and the PLBG-150 tanks made of compressed cardboard treated with a bonding agent, with a capacity of 150 litres (33 Imp gal). As a result of comparative trials, the choice fell on the PLBG-150 tanks which were adopted for production and service use.

A two-seat IL-2 AM-38F fitted with two such tanks passed State acceptance trials between 19th September and 10th October 1943. Their introduction, however, was not trouble-free; it took some time to overcome problems with the incomplete use of fuel from these tanks. The use of drop tanks carried on underwing bomb shackles entailed, naturally, a reduction of the ordnance load and the armament for a given mission had to be restricted to the cannon and rocket projectiles.

IL-2 AM-38F production two-seater – improvements to the armament

Much attention was paid to constantly improving the efficiency of the aircraft's armament, including the bombing armament and rocket projectiles.

Ilyushin Aviation Complex

Above: A mid-production two-seat IL-2 with a tall aerial mast (its length was increased from 350 mm/13¾ in to 800 mm/31½ in). Note the altered shape of the rear cockpit canopy. Note the different shape of the cannon fairings; no wing cannons are fitted.

Ilyushin Aviation Complex

Above: This early two-seater features an abbreviated rear cockpit canopy. Note the angle at which the defensive machine-gun could elevate.

Ilyushin Aviation Complex

This two-seat IL-2 has the late-model outer wings with sweepback increased to 15°. Note the late-style insignia outlined in white.

The IL-2's bombing accuracy was severely hampered by the inadequate view forwards and downwards for the pilot, making an accurate sighting impossible. As a means of enhancing the accuracy of bombing, a special timing device known as VMSh-2 (*vremen**noy** mekh**anizm** shtoor-movi**ka***) was developed; it was an automatic device which released the bombs at a preset time after the moment when the aircraft's nose obscured the target. An order issued by NKAP on 8th April 1943 stipulated that Plants Nos 1, 18 and 30 start equipping the IL-2s with these devices; the proportion of the IL-2s thus equipped should be gradually increased and reach 100% from July 1943 onwards. Another improvement of the bombing armament consisted of dispensing with the special KMB boxes for small-calibre bombs that initially had to be fitted into the wing bomb bays. Modifications to bomb bay doors made it possible to load the bombs directly into the bomb bays simply by placing them on the closed doors through hatches on the upper wing surface. Modifications were made to bomb release mechanisms and underwing shackles for the externally carried bombs. The modernised

bombing devices were tested in August 1942 and incorporated on production aircraft. Thus, from 15th October 1942 onwards the IL-2 was manufactured with the modernised bomb bays obviating the need for small bomb boxes.

Initially the IL-2 was equipped with RO-82 launch rails for eight 82-mm (3.22-in) RS-82 rockets. Experimentally, early in 1942 the number of launch rails on some single-seat IL-2s was increased, enabling them to carry 14 projectiles of the 132-mm calibre (RS-132) or a combination of eight 82-mm and eight 132-mm projectiles. Presumably, this was done at the expense of the bomb load. IL-2 pilots did not consider the RS-82 projectiles to be a very effective weapon and expressed their preference for the heavier 132-mm rockets; they were particularly impressed by the armour-piercing RBS-132 and high-explosive/fragmentation ROFS-132 projectiles introduced in the course of the war (from the spring of 1942 the armour-piercing RBS-82 and RBS-132 came into use, supplemented by the V-8 and M-13 projectiles later in the year. The last-mentioned two types were improved versions of the RS-82 and RS-132 respectively). An idea cropped up of using rocket projectiles for the protection against enemy fighters attacking from the rear; in August 1941some IL-2s were fitted with a pair of launching rails for the rearward firing of rocket projectiles which proved useful in scaring away the attacking fighters. In mid-1943 a two-seat IL-2 AM-38F was fitted with eight (!) launch rails for rearward-firing rocket projectiles.

Experiments were made with different kinds of weaponry on the IL-2. Notably, in 1941-42 attempts were made to equip the attack aircraft with a flamethrower. A series-produced UKhAP-250 flamethrower was used; it was filled with 100 litres (22 Imp gal) of petrol mixed with 4.2 kg (9¼ lb) of aluminium naphthenate. Flight tests showed that at speeds of 320-340 km/h (200-210 mph) that were usual for the IL-2 the density of the burning mixture at ground level was too low to produce a worthwhile effect, even if the aircraft was flying at a height of no more than 10 m (30 ft). The device was found to be unsuitable for combat use.

In August 1942 a single IL-2 was experimentally fitted with an aircraft mortar designed by Potanin. The testing was conducted at the Research Test Range of Aircraft Armament (NIPAV – *Na**ooch**no-is**sle**- **d**ovatel'skiy poli**gon** aviatsi**on**novo vo'oroo-**zhen**iya*). The mortar tube with an 82-mm bore was provided a loading mechanism, containing six rounds of ammunition. The mortar was mounted with its axis set at an angle of 43° upwards and rearwards. To minimise the recoil, an elastic mounting was used. The mortar shell was fitted with a special inertial fuse. Thirty aerial firings were performed in the course of six test flights. The automatic loading mechanism proved troublesome; there were three cases of the shell jamming. When fired at a speed of 320 km/h (199 mph) at an altitude of 1,000 m (3,280 ft), the mortar shell exploded 280 m (920 ft) behind the aircraft and some 70 m (230 ft) above it. The results were deemed generally satisfactory, but the supply of six rounds was considered insufficient and it was decided that it should be increased to fifteen. The final results of the tests are not known.

IL-2 AM-38F two-seater as a naval aircraft

The IL-2 was widely used by the Soviet Navy's air arm (AVMF – *Avi**ah**tsiya Voy**en**no-mor**sko**vo **flo**ta*). Skip bombing was an especially effective method against surface ships; the aircraft approached the target at 30 m (100 ft) and about 400 km/h (250 mph), dropping the bombs so that they bounced off the water into the ship's side. The Russian term for this method is *top**mahch**tovoye bombome**tah**niye* ('mast-top bombing'), since the bomber approaches at mast-top level. Here it should be noted that, according to some sources, the naval career of the IL-2 included its use as a torpedo-bomber. Descriptions have appeared of a torpedo-carrying version of the IL-2 allegedly designated IL-2T (*torpedo**no**sets*). One source claims that in the summer of 1944 a flight of IL-2Ts was operated on a permanent basis by the 23rd Independent Attack Air Regiment (OShAP) of the Black Sea Fleet. The aircraft in question had the new outer panels featuring increased leading-edge sweep. The VYa cannon were deleted. The Model 45-36AN torpedo weighing 940 kg (2,073 lb) measured 5,45 m (17 ft 10½ in) in length and 450 mm (17¾ in) in diameter; it was attached to the underside of the fuselage at an angle of some 10° by means of two curved tubular struts with cartridges inside the attachment fittings of the torpedo. Another source claims that the 12th ShAP of the Black Sea Fleet Air Arm equipped IL-2s with US-made torpedoes of 533 mm (21 in) calibre.

This information has been contested by some Russian aviation historians who are extremely sceptical about the existence of the IL-2T. They point out that no documentary evidence has been found to corroborate the use of torpedoes by the IL-2. Significantly, the book *Naval Aviation in the Great Patriotic War* dealing in detail with the IL-2 operations makes no mention whatever of the IL-2T. The issue may well be regarded as unresolved.

IL-2I fighter version prototype

The varied tasks fulfilled by Ilyushin's attack aircraft during the war included the rather unusual use of IL-2 as a fighter. Of course, the Soviet attack aircraft were inferior to the Messerschmitt Bf 109 and the Focke-Wulf Fw 190 in the counter-air role; still, they could conduct air attacks with a fair degree of success against slower and less advanced aircraft of the Luftwaffe. The operational experience of many attack air regiments included cases when IL-2s attacked formations of Junkers Ju 87 dive bombers whose 7.92-mm defensive machine guns were of little effect against the armoured attack aircraft.

During the winter of 1941-42, IL-2s were very active against German transport aircraft. When the Junkers Ju 52/3m transports began intensive operations to relieve the German troops encircled near Demiansk, they found the IL-2 to be one of their most deadly adversaries. The pilots of the 33rd GvShAP were the first to try their hand in these operations. Equally successful were IL-2 operations against the German transport aircraft near Stalingrad. There, in addition to the 'Auntie Ju', the IL-2s attacked Heinkel He 111 bombers and Fw 200 Condor transports delivering supplies to the encircled German troops.


Yefim Gordon archive

This winter-camouflaged and unspeakably dirty IL-2 with a short aerial mast carries only two RS-82 rockets under each wing.

The accumulated combat experience prompted the Soviet Government to issue in May 1943 an order stipulating the development of a fighter version of the IL-2. As early as July 1943 Sergey Ilyushin produced a version of the IL-2 optimised for use as a 'bomber killer'. It was designated IL-2I (*istre**bi**tel'*, fighter). It was a single-seat IL-2 converted from a standard production two-seat attack aircraft with an AM-38F engine (it was a machine manufactured by Plant No.1, c/n 7581). The wings were reinforced. The IL-2I was stripped of ShKAS machine guns, internal bomb bays and rocket launch rails. The armament was reduced to two VYa cannon with 150 rpg. Thus the IL-2I's weight of fire was 4.0 kg/sec (8.8 lb/sec), which was considerably more than contemporary Soviet production fighters possessed.

In July-August 1943 the IL-2I underwent State trials at NII VVS. The test report stated that the modified single-seater's performance improved only slightly as compared to the two-seater. The report added: *'The IL-2I can only be used to fight against certain types of aircraft possessing relatively low speeds at altitudes up to 4,000 m'* [13,120 ft].

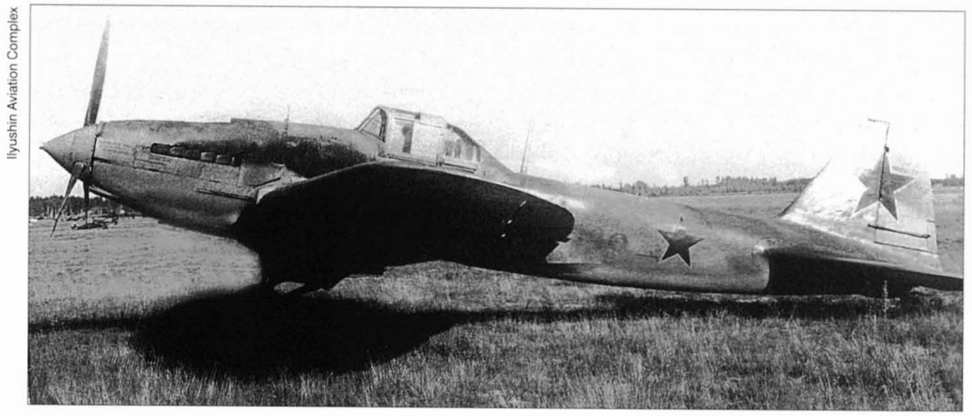
The IL-2I could easily attack Ju 87 and He 111 bombers, as well as enemy transport aircraft. However, it was no good against the latest German fast bombers and fighters. Hence the C-in-C of the Red Army Air Force concluded that there was no point in further manufacture of the IL-2I as a fighter.

IL-2KR production artillery spotter/reconnaissance aircraft

In response to insistent demands from the Air Force Ilyushin developed an artillery spotter/reconnaissance version of his attack aircraft – the IL-2KR (*korrekti**rov**schchik*). It was built in prototype form in March 1943 and introduced into service in the summer of that year. Actually, attempts to adapt the IL-2 to this role had started much earlier, when the combat two-seat versions were not yet available. Therefore, a two-seat UIL-2 trainer (described below) was evaluated in the artillery spotter/reconnaissance role. In July 1942 special comparative tests were conducted with two aircraft – an UIL-2 and a Yakovlev Yak-7 fighter – in order to determine which of them was more suitable for adaptation to the spotting/reconnaissance role. The UIL-2 was found to be more suitable for the purpose, but it required a number of modifications. When asked to develop the properly equipped prototype, Ilyushin initially claimed that the AM-38-powered two-seat IL-2 was unsuitable for this modification, insisting that the two-seat IL-2 M-82 was more easily adaptable for the role. However, the demise of the latter left Ilyushin no choice. The IL-2KR was developed from the two-seat IL-2 AM-38F. It retained the basic airframe and armament of the standard aircraft, the changes being confined to the equipment, fuel system and armour plating. The RSI-4 radio was replaced by a more powerful unit (RSI-3*bis*), and an AFA-1 or AFA-1M camera was installed in the rear fuselage. Outwardly the IL-2KR differed from the standard IL-2 in having the aerial mast mounted on the windscreen (instead of a more aft position). This version acquitted itself well in service and was well liked by pilots, but there were complaints about the lack of armour protection for the gunner/observer. An attempt to rectify this shortcoming by extending the armour plating to the sides of the rear cockpit was not made until April 1945, when a single example was modified in this manner. It was not put into series production because the end of the war was near. In the summer of 1944 the number of the IL-2KR aircraft equipping the artillery spotting elements of the Air Force amounted to 80% of the required strength, and requests were sent to the industry for stepping up production of this version. Some IL-2s were converted to IL-2KR standard in the field, being fitted with various types of cameras for oblique photography at low altitudes. Experience showed that one camera was insufficient for registering the reconnaissance information, and additional cameras were installed in field conditions in the front parts of the undercarriage fairings.

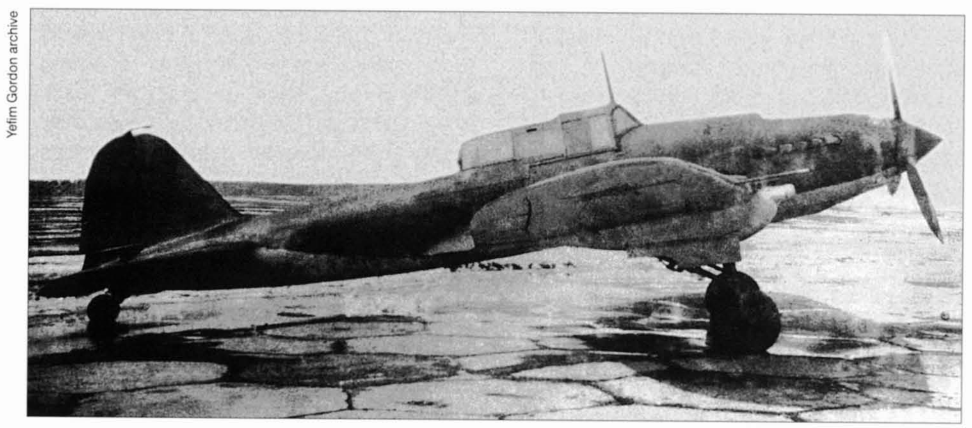
Ilyushin Aviation Complex

Ilyushin Aviation Complex

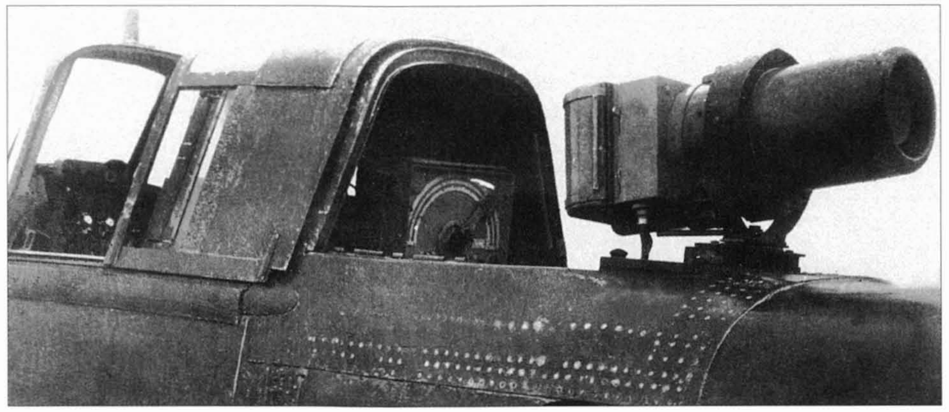


Top and above: This single-seater was the prototype of the IL-2I – an attempt to adapt the *shturmovik* for the fighter role.

Yefim Gordon archive



The prototype of the IL-2KR artillery spotter/reconnaissance aircraft at NII VVS. This version was identifiable by the forward location of the aerial mast.



Yefim Gordon archive

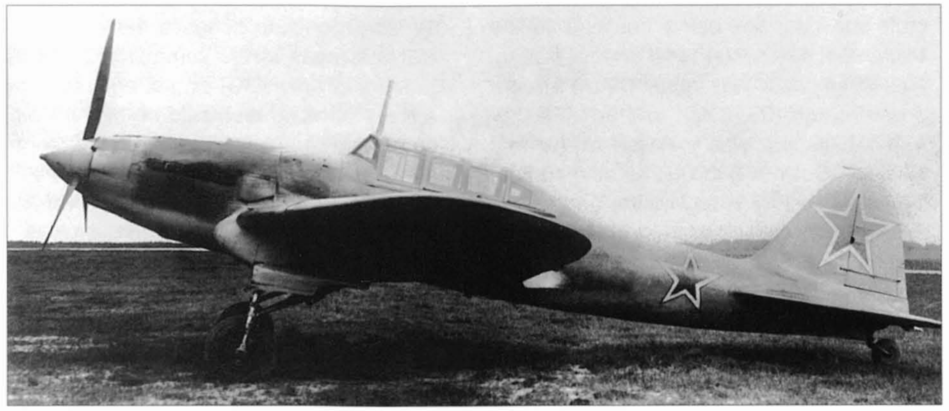
Above: A huge manually trained swivelling camera could be the installed in lieu of a machine-gun on the IL-2KR reconnaissance aircraft for oblique photography. Note the radio set installed for real-time voice link transmission of intelligence data.

In some cases these cameras were mounted externally on top of the fuselage, supplanting the rear machine-gun.

UIL-2 (IL-2U) production dual control trainer

The training of attack aircraft pilots was no easy task. To cope with it the 1st Reserve Air Brigade was established in Kuibyshev (it was later awarded the Order of the Red Banner of Combat for its activities). By the beginning of August 1941 eight attack air regiments with 306 IL-2s and 292 trained pilots were transferred to the front. Later, more than a thousand pilots were undergoing training every month, and the need for a dedicated trainer version of the IL-2 became increasingly acute.

A dual-control version of the IL-2 was first requested in 1940 and was designed as early as April 1941 (some sources indicate that the first example of the TsKB-55, later modified and renamed TsKB-57, was reconverted to a two-seat configuration and fitted with dual controls by 9th April 1941 and was under testing from 17th July 1941), but it took some time to get its series manufacture under way. At the beginning of January 1942 the Air Force officially asked NKAP to make arrangements for the production of 20 dual-control machines at Plant No.1 in February and March on the basis of drawings from Plant No.18. To simplify production, the Air Force found it acceptable to have them built without the use of armour steel and armourglass which were in short supply. On 7th February the State Defence Committee issued a resolution providing for the manufacture of the dual-control IL-2s, and in pursuance of it, on 9th February 1942 NKAP ordered Plant No.18 to start building the trainer version from 15th February onwards and to turn out 20 machines of this version every month. However, the plant failed to cope with the task citing all sorts of difficulties. It was not before 1943 that the trainer version designated UIL-2 (also referred to as IL-2U, for *oochebnyy* [*samolyot*] – trainer) began to be produced in substantial numbers. On this aircraft the instructor's cockpit replaced the gunner's cockpit; this version differed externally in having an aft fairing of varying shapes. Initial versions of the dual-control trainer had the front fuselage made of ordinary (not armour) steel, but from 1943 onwards the IL-2Us were manufactured with the normal armoured shell fuselage identical to that of combat types. Dual-control trainers were initially powered by AM-38 engines, which were supplanted by later AM-38Fs. A version of the IL-2U produced in January 1945 featured an extended armour shell providing protection for the rear cockpit. The instructor pilot could correct the trainee's errors and demonstrate piloting techniques by means of dual controls. A special version of the UIL-2, armed with two ShKAS machine guns, two RS-82 rockets and a 440-lb (200-kg) bomb load, was used to teach attack aircraft combat techniques.



Ilyushin Aviation Complex

Above: The IL-2U (alias UIL-2) dual-control conversion trainer lacked defensive armament and was easily identifiable by the longer and recontoured cockpit canopy.

Ilyushin Aviation Complex

This single-seat IL-2 with anti-flutter booms has been fitted experimentally with two 37-mm Shpital'nyy ShFK-37 cannons in huge pods. Additionally, the aircraft carries eight RS-82 rockets.

In the course of production the IL-2U was repeatedly modified and improved. In July 1944 a production UIL-2 manufactured by Plant No.1 (c/n 1881100109) was subjected to checkout tests which revealed a number of shortcomings, notably, in the equipment of the rear cockpit. Rectifying these defects continued even after the end of the war. Thus, a modified UIL-2 AM-38F (c/n 18841133) manufactured by Plant No.18 in April 1945, passed State Acceptance trials in the NII VVS between 31st May and 8th June 1945. Here are some of the changes introduced into the new model: to improve the second cockpit, it was provided with a floor and control linkage fairings, the seat was provided with padded back- and armrests; the front cockpit received armour-glass in its windshield and special controls for fixing the flaps in the take-off position; equipment changes included installation of an RSI-3M1 transceiver. The aircraft had been modified with due regard to the results of the previous State Acceptance trials conducted in July 1944 on the UIL-2 c/n 1881100109 which had revealed a number of shortcomings. The new tests were completed with satisfactory results and the mentioned changes were recommended for production. The dual-control IL-2 was more docile in handling and possessed better longitudinal stability than the combat versions; it could actually sustain prolonged horizontal flight with the stick released. Some UIL-2s were equipped for target-towing.

IL-2 single-seater with Sh-37 (ShFK-37) cannon

Attempts to enhance the firepower of the IL-2 by means of equipping it with large-calibre cannon constitute a special chapter in the history of the type's development and combat use. Ilyushin was tasked with producing a version of the IL-2 armed with 37-mm cannon as early as the spring of 1941. By mid-1941 an example of the IL-2 in its original single-seat production version was fitted with two 37-mm (1.45 calibre) Sh-37 cannon designed by a team led by Boris Shpital'nyy (they were also known as ShFK-37). It passed ground and air firing tests by 15th September and was subjected to State acceptance trials between 23rd September and 12th October 1941. Because of their large size the cannon were installed in underwing fairings and lowered considerably to provide room for a high-capacity ammunition box (each box contained 40 rounds). As a result, the gun mounts became rather complex and large draggy fairings had to be installed (they can be identified by the front parts of the fairing protruding ahead of the wing's leading edge).

The State Acceptance trials revealed that performance of the ShFK-37-armed IL-2 was considerably inferior to that of the standard production version armed with VYa or SVAK cannon. During tests the aircraft attained 231 mph (373 km/h) at S/L and 254 mph (409 km/h) at 7,900 ft (2,400 m) at an AUW of 12,927 lb (5,864 kg). Rate of climb deteriorated and the take-off-run increased; landing speed was 90 mph (146 km/h). Moreover, the Sh-37 proved unreliable and the low position of the cannons relative to the aircraft's CG caused the IL-2 to pitch down when the cannon were fired, reducing firing accuracy. Manoeuvrability of the aircraft deteriorated markedly – it became more sluggish and difficult to handle.

At the end of December 1942 eight Sh-37-armed IL-2s arrived into the 688th Attack Air Regiment of the 228th Attack Air Division of the 16th Air Army for service trials (they were joined by one more machine in January). The aircraft took part in combat in the Stalingrad area in January 1943. Combat experience revealed both the advantages of the new armament and its weak points. Armour-piercing/incendiary shells fired by the Sh-37 pierced the armour of German light tanks and, under certain conditions, of medium tanks and could be considered an effective weapon against armoured vehicles, when used by skilled pilots. However, it was not an easy task to achieve the necessary firing accuracy when using these weapons. This was due to the heavy recoil of the cannon and poor synchronisation of their firing; together these phenomena caused the aircraft to veer off the sight line and led to very poor accuracy. The pilot could not afford to use more than two or three rounds in a single burst if he were to achieve any precision. Moreover, the new cannon proved rather unreliable, and not infrequently one of the two cannon jammed. Firing a single Sh-37 cannon was, for all practical purposes, impossible because the aircraft immediately turned in the direction of the firing cannon. All this lessened the usefulness of the new IL-2 version and could hardly endear it to the front-line pilots who voiced their rather negative appraisal of it. As a result, the IL-2 armed with the ShFK-37 (Sh-37) cannon was not placed in large-scale production.

Russian Central National Economy Archive

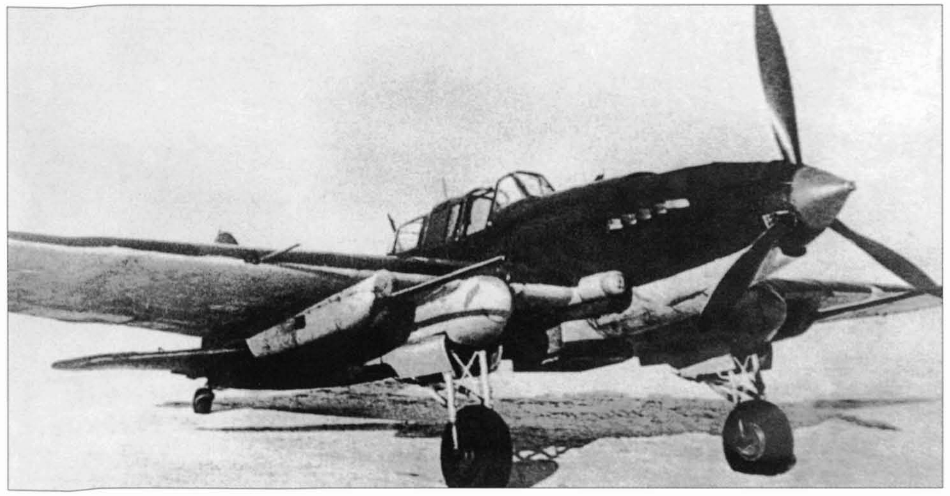
Above: A close-up of the starboard ShFK-37 cannon with the fairing removed.

Russian Central National Economy Archive

The port cannon mount of the same aircraft with the cannon removed; note the rocket launch rails.

IL-2-37 production two-seat aircraft with NS-37 (11P-37) cannon

Yet, the need for the attack aircraft capable of effectively destroying German tanks and



Ilyushin Aviation Complex

An early-production two-seat IL-2 armed with Nudelman/Suranov NS-37 cannons. The more compact and streamlined cannon pods are readily apparent.

other armoured vehicles was acute, and further efforts were made to tackle the task. In March-April 1943 two new, advanced 37-mm NS-37 (11P-37) cannon designed by Nudelman and Suranov were installed in a two-seat IL-2 AM-38F. The cannon were belt-fed, which allowed them to be attached directly to the wing underside; they were enclosed by relatively small fairings, the front ends of which sloped rearwards, as distinct from the forward-protruding fairings of the Sh-37 cannon. Each cannon had 50 rounds loaded directly into the wing instead of traditional ammunition boxes. If necessary, the aircraft could carry up to 200 kg (440 lb) of bombs in overload configuration. The launch rails for rocket projectiles were removed.

A small batch of IL-2-37s, as the type was designated, was manufactured at Plant No.30 and underwent service trials with the 208th ShAP during the Kursk Battle. In the opinion of the pilots, the handling techniques of the new variant did not differ from those of a fully loaded two-seat IL-2. The fairings and the distribution of large masses in the wings (one gun with ammunition weighed 237 kg/552 lb) increased the aircraft's inertia and made it more sluggish. In addition, there were certain difficulties with aiming. It was all but impossible to fire more than one round at a time with any accuracy because the poor synchronisation of the guns, coupled with their powerful recoil and location far from the fuselage, caused the aircraft to yaw violently. Thus the new weapon inherited the problems encountered with the Sh-37 cannon.

To ensure the most effective use of the NS-37 cannon, steps were taken to train the front-line pilots in firing the weapon in short bursts against point targets. Recommendations were issued to the designers and manufacturers of the weapon that the NS-37 cannon be provided with a muzzle brake. Express instructions required that the IL-2 armed with the NS-37 cannon be provided with 50 rounds of ammunition per cannon and a normal bomb load of 100 kg (220 lb). This helped to enhance the efficiency of the aircraft to some extent. Again, in the hands of a skilled pilot the NS-37-armed IL-2 was a formidable weapon system capable of destroying even Tiger tanks; it was considered to be especially effective against all kinds of motor vehicles, railway trains, ammunition and fuel depots. Yet, it did not see widespread use.

A contributing factor to this was the emergence of an effective 'alternative' method of destroying enemy tanks and armoured vehicles. It was the use of shaped-charge cluster bombs which had been developed under the leadership of I. Larionov and put into production by the summer of 1943. The small bombs known as PTAB 2.5-1.5 were loaded directly into the bomb bay and dropped on enemy vehicles from altitudes up to 100 m (328 ft).

The NS-37-armed IL-2s could carry only a 100-kg (220-lb) bomb load versus the 400 kg (880 lb) carried by the standard-armament IL-2s. This reduction, in the opinion of front-line pilots, was not compensated by the greater firepower of the 37-mm cannon lacking the necessary precision. The front-line pilots who had flown the NS-37-armed machines were unanimous in their preference for the VYa-23-armed version capable of carrying a greater bomb load; they considered this armament fit more versatile and better suited for the prevalent mission types.

The NS-37-armed IL-2s could carry only a 100-kg (220-lb) bomb load as against the 400 kg (882 lb) carried by the standard-armament IL-2s. This reduction, in the opinion of front-line pilots, was not compensated by the greater firepower of the 37-mm cannon lacking the necessary precision. The front-line pilots who had flown the NS-37-armed machines were unanimous in their preference for the VYa-23-armed version capable of carrying a greater bomb load; they considered this armament fit more versatile and better suited for the prevalent mission types.

To make a long story short, the results of service trials of the IL-2s armed with the NS-37 cannon were considered unsatisfactory, and in November 1943 a decision was taken to discontinue the series manufacture of this version. Plant No.30 received an order to switch over completely to the manufacture of the IL-2s armed with 23-mm VYa cannon by 15th January 1944. Thus, from January 1944 onwards, all aircraft factories engaged in the production of the IL-2 manufactured the aircraft only in the VYa-armed version. In all, 947 NS-37-armed IL-2s had been produced as of 7th December 1943; there were plans to bring this figure to 1,175 by 15th January 1944.

Prototype versions of the IL-2 with 45-mm cannon

In a further quest for enhancing the firepower and combat effectiveness of the IL-2 against armoured and well-protected targets, a decision was taken to produce a version of this aircraft armed with 45-mm cannon. On 22nd August 1943 NKAP issued two orders – No.507s and No.508s – requiring the Ilyushin OKB to build two prototype IL-2 aircraft armed with two 45-mm cannon each; both were to be presented for state acceptance trials by 5th November 1943. One of these machines was to be armed with the cannon designed by OKB-16 (Nudelman and Suranov) later to be known as NS-45, the other one with similar cannon designed by OKB-15 (Shpital'nyy). A prototype IL-2 AM-38F armed with two NS-45 cannon was submitted for State Acceptance trials on 10th September 1943 (some sources state the date as 13th September and even 2nd November 1943). The State Acceptance tests lasted until 8th February 1944.

Test firing of the new cannon in the air revealed its low effectiveness against point targets. This was due mainly to the excessive recoil of the cannon. In consequence, the machine with NS-45 cannon was not put into series production. As for Shpital'nyy's weapon (the Sh-45), an official report dated 30th October 1943 stated that an IL-2 armed with Shpital'nyy cannon *'had been completed on 27th October and had not yet been flown to the NII VVS because of bad weather.'* No further information on this particular aircraft is available, but some sources indicate that plans to install the Shpital'nyy 45-mm cannon on the IL-2 were abandoned.

In response to criticism concerning his large-calibre cannon Nudelman undertook successful attempts to reduce considerably the recoil force of both the NS-45 and the NS-37 cannon by equipping them with muzzle brakes. Nudelman even claimed that the new version of the NS-37 could be fired singly on the IL-2 without compromising the precision of aiming. However, according to some researchers, these modified cannon (NS-45M and NS-37M respectively) were not installed on the IL-2. There is, however, a photo depicting an IL-2 with a large-calibre cannon (37- or 45-mm) the barrel of which is apparently fitted with a muzzle brake.

IL-2 tank buster prototype with 14.5-mm VYa cannon

Curiously, in seeking to enhance the IL-2's efficiency as a tank buster, Ilyushin did not rely solely on increasing the calibre of the cannon installed in the aircraft. Actually, he resorted to just the opposite – at one time he seriously studied the possibility of reducing the calibre of the VYa cannon to 14.5 mm (.57 calibre)! This would have enabled the VYa cannon to make use of the 14.5-mm armour-piercing rounds of anti-tank rifles which had demonstrated their high penetrating power. On 14th November 1942 Ilyushin wrote to A. I. Shakhurin: *'An armour-piercing shell has been developed for the Volkov-Yartsev cannon mounted on the IL-2 by reducing its calibre to 14.5 mm while leaving the size of the shell case unaltered. Tests have shown that this armour-piercing shell penetrates the armour of 50-mm* [2-in] *thickness at a distance of 150 m* [490 ft]. *It is necessary, as a matter of urgency, to design and manufacture a loading system for this kind of ammunition on the IL-2 aircraft and conduct appropriate tests.'* Ilyushin sought permission to design this new system and asked the People's Commissar to give instructions to Plant No 18 requiring it to install this new system on a production example of the IL-2. Accordingly, on 17th November NKAP issued order No.482s entrusting Ilyushin with designing the new ammunition feed system for the VYa cannon adapted to the 14.5-mm armour-piercing shell; director of Plant No.18 Belianskiy was obliged to turn out two IL-2s equipped with the new munition feed for the VYa cannon by 15th December 1942. No information is available as to the final result of this experiment.

To wind up the story of the IL-2's development, a few words have to be said about the final phase of its production career. It was manufactured in huge numbers, overall production totalling 36,154 machines. In 1944 the IL-2 was joined on the production lines by its younger and more efficient stablemate, the IL-10, which is described separately. Production of the two types continued in parallel in 1945, the proportion between them gradually changing in favour of the IL-10. As the manufacture of the latter gradually gained tempo, production of the IL-2 tapered off. This can be exemplified by figures referring to the production activities of Plant No.18. In the second half of 1944 the plant was tasked with introducing the IL-10 into series manufacture without impairing the overall output of attack aircraft. This task was tackled successfully. In January 1945 the plant turned out 50 IL-10s and 225 IL-2s, in March the figures were 90 and 207 respectively, and in May 163 and 112. For the year of 1945 as a whole, production figures for the Plant No.18 were 1315 IL-10s and 943 IL-2s.

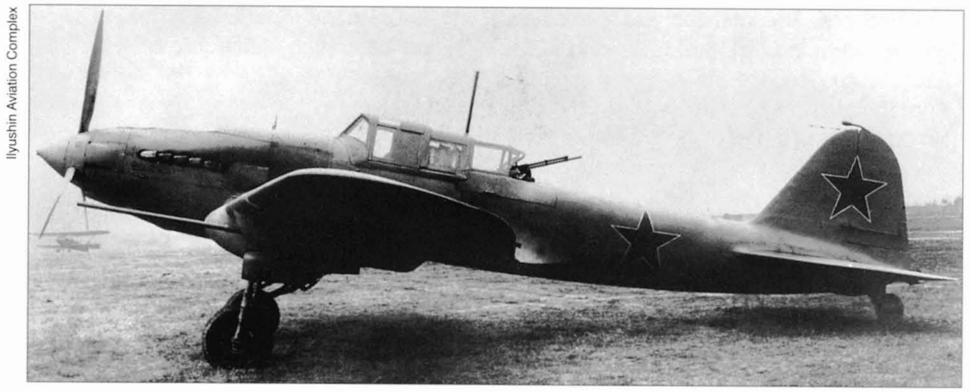
After the end of the war manufacture of the IL-2 continued for some time, but was quickly brought to a close. Plant No.1 stopped producing the IL-2 in June 1945, Plant No.18 did the same in July 1945, while at Plant No.30 it was not before October 1945 that the IL-2 was finally phased out of production.

The IL-2s that had survived the war remained on the strength of the Soviet Air Force's attack air units for a while. The intention was to phase them out as soon as possible and the re-equip the attack element of the Air Force completely with more modern IL-10s and IL-16s (also described below). However, this process proved to be more time-consuming than originally anticipated, and it was found expedient to prolong the period of service of the remaining IL-2s. In March 1946 a draft resolution of the Government was prepared instructing the People's Commissariat of the Aircraft Industry to supply 1,500 metal rear fuselages for the IL-2s to

Ilyushin Aviation Complex

Above: A late two-seater armed with NS-45s during State acceptance trials (note the tall aerial mast).

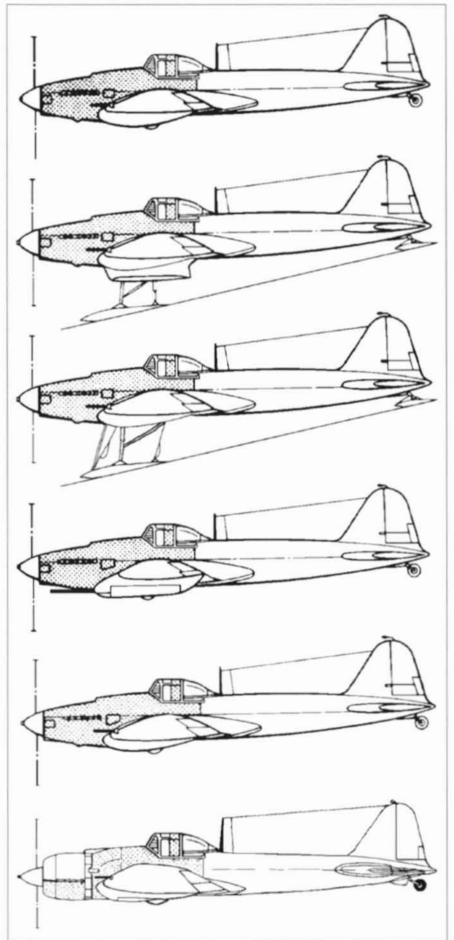
Ilyushin Aviation Complex



Above: Another mid-production aircraft with NS-45 cannons.

Ilyushin Aviation Complex

This IL-2 is armed with heavy cannon (possibly of 45-mm calibre) whose type remains unknown. Note the shape of the cannon pods protruding beyond the wing leading edge.



Via AVICO-Press

Top to bottom: a standard single-seat IL-2, a single-seater with retractable skis, ditto with non-retractable skis, a single-seat IL-2 with 37-mm cannon, the IL-2I, the projected IL-2 M-71.

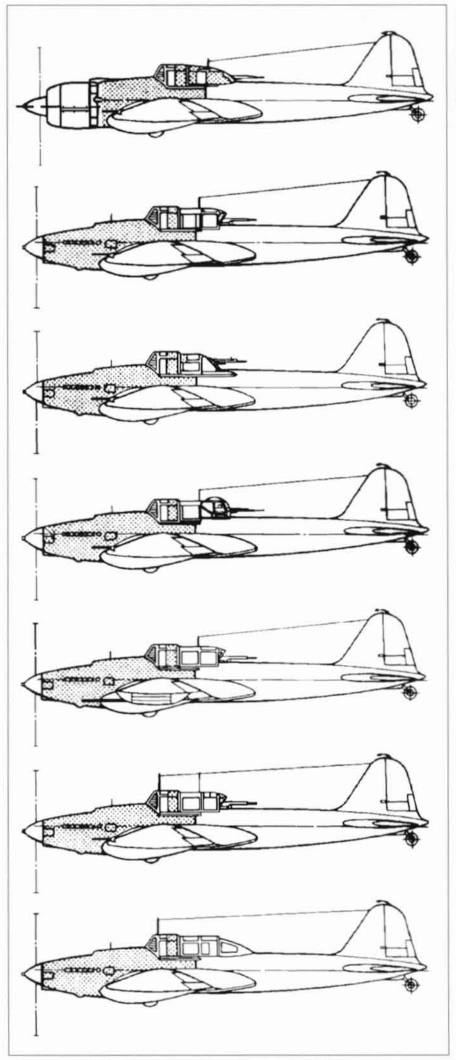
the Air Force. The intention was to replace the wooden tails of the IL-2s and thus increase the service life of these aircraft. Appropriate orders were issued to Plant No.30, but on 19th April 1946 the Air Force curtailed this order to 700 metal rear fuselages. This order was further halved to 350 pieces on 1st May 1946; moreover, now they were intended not for the combat machines but for the UIL-2 trainer aircraft. The new rear fuselages were to be produced and mounted on the IL-2s before 1st January 1947. By 16th November this refurbishment was effected on 143 machines, and the work went on. Events proved the above-mentioned curtailment of the order for the new tails to be a rash decision. On 21st December 1946 Commander-in-Chief of the Air Force K. A. Vershinin sent the following request to Minister of the Aircraft Industry Khrunichev: *'Bearing in mind that the estimated manufacture of 1,900 IL-10 aircraft (including 200 combat trainer versions) in 1947 will fall short of our need for attack aircraft, the IL-2 aircraft must be retained in squadron service until the middle of 1948; their service life must be extended by replacing wooden parts of the fuselages by metal ones. To effect these measures, 1,298 metal rear fuselages of the IL-2s must be manufactured.'* Documents elucidating a further sequel to this story are not available.

The IL-2 in action

By the time the Great Patriotic war broke out, only 18 IL-2s had been delivered to the western military districts of the USSR, yet none of them had been flown and mastered by aircrews. Not a single aircraft of this type succeeded in joining combat against the Luftwaffe on 22nd June 1941. Among the first units to receive the new aircraft in Voronezh was the 4th ShAP commanded by Major S. Getman. Before the outbreak of the war the pilots had just enough time to make several circuit flights and flights into a designated zone. Instead of the statutory complement of 65 IL-2s the unit had only 17 machines on strength. Nevertheless, as early as 1st July 1941 the regiment had its baptism of fire in the vicinity of the Berezina river and the town of Bobruisk. The IL-2s attacked enemy tanks when they gathered in large numbers in disembarkation or concentration areas or on the march. Less frequently the attack aircraft were used for destroying various targets directly on the battlefield. The Air Force command and the senior officials of NKAP very quickly became aware of the usefulness of the aircraft and did their best the ensure that as many such machines as possible should reach attack air regiments.

As a rule, at the initial stage of the war IL-2 sorties were performed by one or two flights consisting of three aircraft which flew at low altitudes without the benefit of a fighter protection. They made several passes at their target from different directions. This reduced the concentration of enemy AA fire and helped reduce own losses. When undertaking a strike against a target, two kinds of attack were mostly employed. The first of them consisted of bombing from altitudes that ranged from the minimally admissible (hedge-hopping flight) to 150 m (490 ft). The second was an attack pressed home after a zoom climb that was made after approaching the target area at a low altitude; the IL-2s zoomed to an altitude of 300-400 m (980-1,300 ft) and then used their weapons in a shallow dive.

At that time official instructions stipulated that the IL-2s should undertake their attacks from different altitudes, the time interval between the groups of aircraft being 10 to 15 minutes. To curtail the time elapsing between the issuance of a combat order and the actual strike against the target, small groups of aircraft were stationed at airfields situated at the distance of 15-20 km (9-12 miles) from the frontline. Before performing



Via AVICO-Press

Top to bottom: the IL-2M-82, an early two-seater, the IL-2*bis*, the experimental IL-2 with an MV-3 'ball turret', a two-seater with cannon pods, the IL-2KR and the IL-2U.

a mission, especially when it was flown at extremely low altitudes, the pilots carefully studied the combat action area taking note of reference-points and recognisable features in the vicinity of the target. However, it was no easy task even for experienced pilots to find and hit the target when flying at extremely low altitudes. Therefore attack air units enlisted the assistance of a pathfinder aircraft flying at a medium altitude and seeking out the target. Usually Tupolev SB bombers served as lead aircraft.

Surprise raids delivered by attack aircraft flying at extremely low altitudes formed the basis of their tactics However, as the number of aircraft in the Air Force units grew, the tactics were steadily refined.

The Germans gave up their practice of sending the troops on a march in compact columns along main roads. They began using forest lanes and country roads; tanks and other vehicles using camouflage now advanced at large intervals making use of anti-aircraft defences. Under the conditions thus changed attack aircraft resorted to concentrating their combat effort and chose as their targets enemy troops at assembly and refuelling points and on the march. To put this into effect, precise intelligence information was needed. At first, it was provided by reconnaissance aircraft that were not in the inventory of the attack air units.

The next step consisted of organising own air reconnaissance in attack air units. Reconnaissance missions were performed by the most experienced aircrews of the attack aircraft.

At the end of October 1941 evacuation of the factories led to a temporary halt in the deliveries of the IL-2s to the frontline units. By that time the German army commenced its 'decisive' offensive against Moscow known as Operation *Typhoon*. The number of IL-2 aircraft opposing the enemy at all fronts totalled 144 machines, only half of them being in airworthy condition. Out of this number, only 36 attack aircraft were assigned to the front sector opposing the Wehrmacht at the direction of its main blow. In the ranks of the Soviet aviation grouping note must be made of the 215th ShAP commanded by Major L. Reino whose pilots courageously fought the enemy. The regiment performed strafing missions against the enemy's vehicle and tank columns in the area of Dukhovshchina and Yartsevo. Usually every group of the attack aircraft was headed by the leader on a Pe-2 aircraft who performed the target designation for the IL-2 pilots. After the leader's signal the attack aircraft made a zoom climb and, having gained altitude, dropped bombs and fired unguided rockets at the target; then they descended again to a lower altitude and put their cannon and machine-guns into action.

Commander of the 65th ShAP Major Vitrook was the first to use the IL-2 for attacking enemy bombers.

In the winter of 1941-42 the IL-2 aircraft were very active in combating the German transport aviation. When the three-engined Ju 52/3ms started their intensive flights into the 'Demyansk pocket' to the rescue of the encircled German troops, they found the IL-2 among their most dangerous opponents. Just as successful were the actions of the IL-2s against the German transport aviation near Stalingrad. There the Ilyushins were up against not only Ju 52s and He 111s but also Fw 200s which were used for flying supplies to the encircled German group.

In the winter of 1941-42 the first summing up of the results of the IL-2's combat use was made. Practical experience of combat performed by the attack aircraft showed that on the average an excellently trained pilot could knock out two German tanks at a distance of 300-400 m (980-1,300 ft), using his cannon and unguided rockets, provided he had made a successful pass at the target; a pilot with a satisfactory level of training could knock out one tank. The success of the IL-2 was in no small part enhanced by the fact that some of these aircraft were armed with VYa cannon which were more potent than the ShVAK cannon, albeit with a somewhat inferior rate of fire. The machine-gun fire of attack aircraft was also very effective against troops, personnel, transport vehicles and other soft-skinned targets.

In the summer of 1942 the German forces undertook a major offensive on the southern flank of the Soviet-German front. Attack air units, already with very substantial numbers of aircraft on strength, tried to frustrate the enemy's advance near the Don River. The missions were usually flown by small groups of the IL-2s attacking German columns on their march across the steppes.

A special order issued by the People's Commissariat of Defence (NKO – *Narodnyy komissariaht oborony*) contained an analysis of the shortcomings in the combat utilisation of attack aircraft and recommendations as to their correct use. The order read in part as follows: *'We must immediately give up the harmful practice of underestimating the IL-2 in the day bomber role and see to it, that not a single IL-2 takes off for a combat sortie without a full bomb load.'*

A stringent control was set up so as to ensure that the bomb load should not be less than 400 kg (880 lb).

On the 30th October 1942 the IL-2s of a new production version – the two-seat AM-38-powered machines – were committed to action for the first time. The machine gun for rear defence installed on the two-seat aircraft became an effective means of ensuring protection against enemy fighters. During the service evaluation period alone the IL-2 gunners shot down seven Bf 109 aircraft and repulsed a large number of attacks made by the enemy fighters.

Commander-in Chief of the Red Army Air Force Air Marshal Aleksandr A. Novikov wrote that during the battle of Stalingrad the ground attack aviation fully justified the hopes pinned on it. *'Attack aircraft were simpler in design and cheaper in production; by virtue of their numbers multiplied by the excellent combat qualities they to a large extent compensated for a certain shortage of bombers that we experienced.'*

Gradually the number of IL-2s in frontline air units grew. The IL-2 ground attack aircraft made up nearly a third of all Soviet combat aircraft. Thus, this aircraft became numerically the most important type on the Eastern front.

In the course of the war the tactics of the ground attack aviation underwent a steady process of improvement. Operational practice proved the expediency of employing battle formations incorporating pairs of aircraft. A group of three aircraft gave place to a group of four consisting of two pairs, a group of six aircraft was supplanted by a

Yefim Gordon archive

A very early single-seat IL-2 (as evidenced by the wingtip anti-flutter booms) taxies out for a sortie.

Yefim Gordon archive

This two-seater taxying out for a mission is a fairly late-production aircraft, as indicated by the tall aerial mast. The tactical number 35 is hand-painted.

Yefim Gordon archive

100-kg bombs were hoisted into place under the IL-2's wings with the help of hand-driven winches.

group of eight comprising two flights of four aircraft each. This immediately increased the effectiveness of strikes inflicted on the target from different directions.

The enemy, too, constantly studied the tactics of the Soviet ground attack aircraft and resorted to his own ways and means of counteracting them. Therefore it was impermissible to always repeat the same tactics and make a routine of it. It was the search for novel elements in the combat tactics of the ground attack aircraft that ensured the success of combat missions. However, certain principles and rules evolved through experience remained a starting point in devising the plan of a mission. For example, there existed definite rules for attacking various types of targets. Certain 'standards' were also used when calculating the required number of aircraft, ammunition complement and the battle formation type.

A directive issued by the C-in-C of the Red Army Air Force on 22nd August 1942 pointed out that combat actions performed by ground attack aircraft at ultra-low altitude deprived the IL-2s of the possibility to use their firepower to the full extent. In addition, operations at extremely low altitudes made it very difficult to take one's bearings, seek out the target and aim at it, as well as to counteract the attacks of enemy fighters. The directive recommended that the bombing altitude be increased and the pilots should master diving attacks and new battle formations. One should approach a target area at altitudes of 800-1,200 m (2,625-3,940 ft) in such formations as 'S-turn in pairs' or 'echelon formation' and perform an attack with due regard to the character of the target and its location in the terrain.

The 'circle' or 'wheel of death' battle tactic used for group attacks against ground targets was an ellipse with its long axis pointing in the direction of the target. After the attack the leader of the group took a position 500-800 m (1,640-2,625 ft) behind the rearmost aircraft in the group and closed the 'circle'. This ensured mutual support and a prolonged fire action against the enemy, as well as a timely suppression of the anti-aircraft defences. Strafing actions from extremely low altitudes or involving a zooming climb to an altitude of up to 300 m (980 ft) were recommended for those cases when it was necessary to achieve a maximum of surprise and when the targets possessed considerable dimensions.

Whereas in August 1941, due to combat attrition, the regiments often had no more than five or six serviceable machines on strength, in November-December 1942 this number grew to 32, and then to 40. However, attack aircraft were as yet unable to operate within the whole scope of the enemy's defences. For example, during the counter offensive near Stalingrad close air support was effected by consecutively trans- ferring the combat effort from one defensive position to another.

Ground attack air regiments and smaller units acting in support of infantry and tank units received their mission tasks directly from the command of land forces. For example, during the Battle of Stalingrad army scouts reported a big concentration of enemy reserves within the city limits. Air Force units were tasked with suppressing the enemy's firepower and paralysing the resistance of its infantry. At dawn bombers dropped their bomb load on the previously located targets. Five minutes later ground attack aircraft raided the German weapon emplacements. They were followed by fighters which started to hammer away at the enemy infantry. After a 20-minute bombardment and strafing by aircraft, Soviet infantry units seized the eastern outskirts of the city with a swift thrust.

In the summer of 1943, the Soviet command took a decision to make use of hollow-charge ammunition for busting heavy pieces of weaponry from the air. The PTAB-2.5-1.5 shaped-charge bombs developed under the direction of I. Larionov were put into production specially for the attack aircraft. These diminutive bombs were loaded directly into the bomb bays of the IL-2s and were dropped from a height of up to 100 m

(330 ft) on enemy tanks and similar vehicles. On impact, the energy of the explosion was concentrated in one direction, literally burning a hole in the armour. Among the first to use the PTAB-2.5-1.5 were the airmen of the 291st ShAD. In a mission flown on 5th July 1943 a group of six attack aircraft led by Lieutenant-Colonel A. Vitrook knocked out 15 enemy tanks in one pass.

During the days of the Kursk Battle General V. Riazanov became a genuine master of the use of attack aircraft *en masse* during warfare characterised by swift actions. He incessantly developed and perfected methods of using the IL-2s in co-operation with infantry, artillery and tanks. The general's command post was constantly within the battle order of the ground forces. Many a time he succeeded in assigning new targets to the air units under his command, designating as the target now the enemy tanks, now the infantry launching a counter-attack, now the enemy bombers which were to be deterred from fulfilling their mission.

However, successes scored in the operational use of the attack aircraft were accompanied by a very high rate of combat attrition. The German command asserted that in 1943 the Russians had lost 6,900, and in the following year, 7,300 attack aircraft. In actual fact, the Germans exaggerated the Soviet losses by a factor of 2.2 as compared to the real figures. Yet, the losses of aircraft in attack air units were very high indeed.

Assessing the main reasons of the high combat attrition, Air Force Commander-in-Chief Aleksandr A. Novikov came to the conclusion that it was due primarily to the disastrous lack of originality in operational tactics. At almost all fronts attack aircraft made use of roughly the same pattern. Irrespective of the situation in the air and on the ground and the character of the target, the Ilyushins approached at the altitude of 1,000-1,500 m (3,280-4,920 ft), made their attack and then left the battlefield in a shallow glide with a left banking turn. In these cases the enemy knew in advance the mode of action of the IL-2s and, before their arrival at the battlefield, took the necessary measures to prepare the anti-aircraft guns for repulsing the attack, the gunners training their weapons to the anticipated altitudes.

An assessment of the IL-2's survivability was conducted in the 1st ShAK. It turned out that the calculations made by the designers of the Ilyushin OKB when selecting the armour distribution layout were corroborated. The underside armour plating could, as a rule, withstand a direct hit of small-calibre flak ammunition. The pilot's cockpit proved to be comfortable and well-protected by armour. One of the IL-2 aircraft hit by flak fire lost one of the elevators, the left

Ilyushin Aviation Complex

This still from a wartime documentary shows the tremendous muzzle flashes created when the IL-2's VYa cannons were fired.

stabiliser and the rudder. On another IL-2 the metal skinning of the wing centre section and the flaps were ripped off; the third aircraft had its fin riddled with bullets. Yet, all these aircraft returned safely to base.

The rear fuselage, outer wing panels and oil cooler proved to be particularly vulnerable to ground fire. It was the wooden parts of the airframe that suffered the greatest damage. When the situation with deliveries of metal to the aircraft industry improved and the plants began manufacturing attack aircraft with metal wings, survivability improved appreciably.

In the works of some researchers one can find interesting statistics related to the wartime combat losses of the IL-2. According to these statistics, the number of IL-2s lost in combat during the war years totalled 10,759 which amounts to nearly 29% of all the aircraft lost by the Red Army. An additional 807 IL-2s were lost by the Naval Air Arm. These causes were distributed as follows: 24% of the aircraft were shot down by enemy fighters (the average figure for the whole war; 60% during the initial period); 43% shot down by anti-aircraft fire; 32% lost for reasons unknown (failed to return from a sortie). About 1% of the IL-2s lost were destroyed on the ground by Luftwaffe strikes.

The IL-2 was also used against German armoured trains (in 1943 at the Ukrainian Front, in 1944 in the Baltic area). In efforts designed to frustrate the enemy's railway transportation the primary object of attacks was the rolling stock at railway stations and on a route. From 1943 onwards the IL-2s came to be used more extensively for strafing actions not only at the battlefield and in the immediate rear behind the enemy lines, but also deeper inside the enemy territory – for example, against enemy airfields, including those situated up to 250 km (155 miles) away from the attack aircraft's base.

Employment of the IL-2 *en masse* at all fronts was facilitated also by the simplicity of its operation and mastering by aircrews and ground crews alike. Attack aircraft pilot V. Yefimov, Twice Hero of the Soviet Union, recalled, *'This was one of the easiest aircraft to master. In operations over the target and in an aerial combat the pilot's attention was not distracted by any complex manipulations with instruments and units. The aircraft forgave even gross piloting errors. I don't know a single case when this aircraft became uncontrollable or entered a spin because of mistakes in piloting technique.'*

The IL-2 attack aircraft was extensively used by the naval air arm. The first naval attack aircraft squadrons were set up in July and August 1941 in the Baltic Fleet and the Black Sea Fleet. Later, Attack Air Regiments and Divisions made their appearance in all fleets (that is, also in the Northern and Pacific Fleets). They went into action against warships and transport vessels at sea, attacked the infrastructure of naval bases and havens, destroyed aircraft parked at coastline airfields, suppressed the anti-aircraft artillery, thus assisting naval bombers and torpedo-bombers, rendered close air support to ground troops and naval landing operations, took part in the destruction of coastal artillery batteries and so on.

In the course of the war naval attack air units made approximately 27,000 sorties, of which more than 50% were missions flown against maritime targets (ships, vessels and submarines at sea, in bases and havens, minefields and the like), about 44% were missions flown against ground troops targets, the rest were strikes against airfields, sorties to provide cover for their own ships at bases, and reconnaissance missions.

The overall result of bombing and strafing attacks undertaken by naval attack aircraft was the destruction of several hundred warships, transport vessels and other naval craft, to mention the maritime targets alone.

Especially effective was the destruction of enemy ships by means of skip bombing performed by the IL-2s. It was effected as follows: the attack aircraft descended to a height of 30 m (100 ft) and flew at a constant speed of about 400 km/h (250 mph) up to the moment when the bombs were released; the bombs then rebounded from the water surface and hit the ship's side. People's Commissar of the Navy Nikolay Kuznetsov assessed the effectiveness of the skip bombing technique to be approximately five times greater than that of the usual level-flight bombing. But this method was also fraught with a great risk for the attacker which had to break through a veritable wall of fire created by the anti-aircraft defences of the enemy ships.

It has to be said that up to 1943 the losses suffered by the IL-2 aircraft from enemy fighter attacks were particularly heavy because VVS fighter cover groups were small in numbers and lacked proficiency in aerial combat. Obligatory training in the conduct of aerial combat was introduced in the 11th Guards Attack Air Division (GvShAD). Pilots Lysenko and Matveyev were the first to master the combat techniques practised by fighter pilots; they shared their experience with the young pilots. In early 1943 several mock aerial combat sessions were organised for training and demonstration purposes over the 11th GvShAD's base airfield; in these sessions the IL-2s were pitted against different versions of Yakovlev and Lavochkin fighters. It transpired that in a dogfight the IL-2 could hold its own against the fighters and even succeeded in being the first to 'open fire' on several occasions.

On 5th February 1943 a group of IL-2s set off for its first mission which consisted of providing cover for the ground forces in a designated area. In the course of patrolling Lieutenant Nal'chik noticed a Bf 109 approaching him from behind. Keeping his self-control, the pilot allowed the enemy fighter to come closer, almost within firing range, and then made a sharp turn, putting his aircraft on a collision course, reducing his speed at the same time. The German pilot, who evidently had not expected such a manoeuvre, took evasive action and overshot. Lieutenant Nal'chik went on to act with confidence, as if he were just training; he banked his aircraft in the opposite direction and placed himself within the banking turn of his adversary. A precise burst followed, and the German fighter went down trailing smoke. Suddenly Nalchik realised that a second Bf 109 had latched on his tail. Simulating unawareness, he let the fighter come closer and then repeated the well-mastered manoeuvre which came as a surprise to the enemy. A potent salvo sealed the fate of this German aircraft as well.

Attack aircraft played an important role also at the closing stage of the war. During the battles preceding the liberation of Budapest the 715th ShAP was stationed at Tököl airfield in the vicinity of the city. The regiment's pilots made up to five sorties a day. When the unit was tasked with destroying a bridgehead and a concentration of troops near a bridge on condition that the bridge itself should remain intact, the airmen removed the UBT machine-guns in order to increase the bomb load and flew their missions without gunners. More than 20 sorties were made on aircraft so configured.

On 2nd May 1945, working together with Douglas A-20G Boston bombers under the cover of Yak-9 fighters, the IL-2s sank the training battleship *Schlesien*. During the assault on Berlin strafing attacks from the air were conducted as a means of supporting the Soviet troops advancing within the city; the attacking aircraft refrained from the use of guns to preclude the risk of hitting friendly troops.

On 25th April two groups of attack aircraft participated together with a tank unit in taking control of Berlin-Tempelhof airfield which stubbornly defended itself and was maintained in working condition. Nine IL-2 aircraft made a landing on the airfield, took up positions with their tails towards the airfield buildings and, using their aft-firing machine-guns, opened fire against the buildings. At the same time Soviet tanks burst onto the airfield.

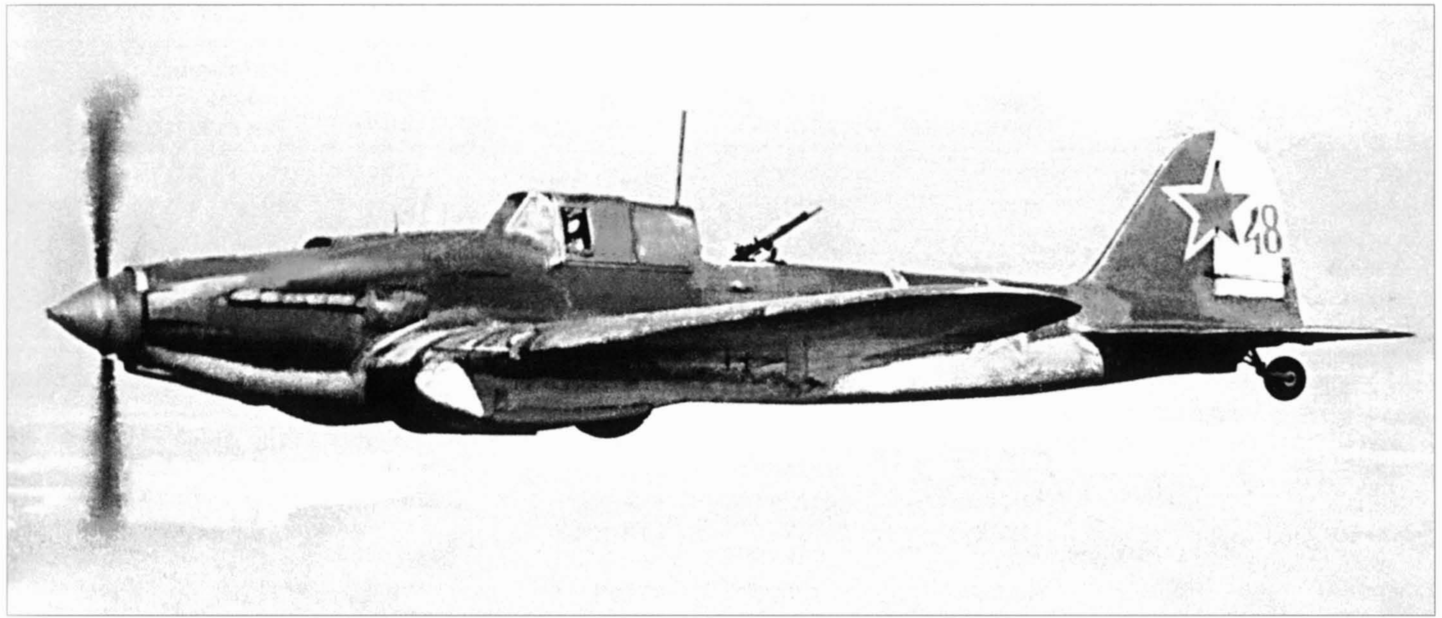
The last combat sortie was flown by the IL-2s against German troops on the territory of Czechoslovakia. The IL-2s were the first to enter Prague when they landed at an airfield captured by insurgents. No precise information is available concerning the participation of the IL-2s in the war against Japan (mention is made only of the IL-10 attack aircraft).

The IL-2 earned a reputation of being one of Red Army's the most effective weapons and was held in high esteem by the Soviet soldiers.

To sum up, here is an assessment made by Russian aviation historians V. Perov and O. Rastrenin who are noted for their in-depth research on the IL-2: *'A searching analysis of the IL-2's design features allows us to say that Ilyushin, after all, failed to fulfil his promise to create a "flying tank" – the aircraft's armour plating could not withstand the impact of cannon shells, and its armament was not on a par with that of a tank. But Ilyushin did succeed in creating a sort of "flying infantry fighting vehicle", an outstanding aircraft which subsequently became an unsurpassed classic among ground attack aircraft. The IL-2 and its derivative, the IL-10 (the latter at the closing stage of the war) were the only production ground attack aircraft in the world during the Second World War period which happily combined good armour protection with a sufficiently potent set of armament comprising cannon, machine-guns, rockets projectiles, bombs, incendiary weapons and chemical devices.'*

Ilyushin Aviation Complex

Service pilots on leave from the frontlines have a meeting with Sergey V. Ilyushin (third from right) and test pilot Vladimir K. Kokkinaki (second from left).



This IL-2 sporting a white rudder by way of squadron markings appears to lack rocket launch rails.

In conclusion, one can quote the assessment of the IL-2 by German land forces commanders during the closing stage of the war. Commander of the Army Group 'Ost-Preussen' General von Sauken wrote: *'The effectiveness of the Russian aviation's actions in the Danzig area is enormous. The Russian aviation in this area has paralysed the manoeuvrability of our troops and has interdicted the transfer of reinforcements towards the front by constantly bringing its might to bear on our communications. We have been unable to oppose this air power, whether it be by our own aviation or by a massive anti-aircraft artillery fire.'* His words are echoed by General Groge, commander of the 1st Heavy Mortar Brigade: *'During the recent battles the Russians have to a large extent resorted to a massive use of attack aircraft. They are an effective weapon for providing support to ground troops. [...] Their moral effect is always exceptionally strong.'*

By far the greatest bulk of the IL-2 attack aircraft was committed to action by the Red Army Air Regiments in 1941-45. During the closing stages of the war a limited number of these aircraft were assigned to air units staffed by Polish and Czechoslovak airmen which later formed the basis of the air forces of Poland and Czechoslovakia after their post-war revival, now as the Soviet Union's allies. The same applies to Yugoslavia. The IL-2s remained on the strength of Attack Air Regiments of Poland and Czechoslovakia for several years before being supplanted by the IL-10 attack aircraft from 1949 onwards. No such re-equipment took place in Yugoslavia due to the rift between Belgrade and Moscow, and the IL-2s soldiered on in Yugoslav service until 1954. Other recipients of the aircraft included Bulgaria and, interestingly, Mongolia.

IL-2 – Structural description

The technical manual defines the IL-2 as an armoured ground attack and bomber aircraft. In the course of 1941-42 the aircraft was manufactured in a single-seat version; from the autumn of 1942 onwards it was equipped with a rear cockpit for the gunner provided with a machine-gun. With regard to dimensions and trimming the two-seat aircraft did not differ from the single-seater. Introduction of the rear defensive installation led to an increase in the weight of the two-seater, as compared with the single-seat version, from 5,750-5,800 kg (12,680-12,790 lb) to 6,050-6,100 kg (13,340-13,450 lb).

Fuselage: The aircraft's fuselage was built in two sections – the all-metal forward fuselage which was formed as an armour shell, and the rear fuselage of wooden construction. The armour shell was assembled from some twenty pieces of armour plating joined to each other by steel rivets and bolts with the help of duralumin sections. Its front part forming the engine cowling of streamlined shape comprised two parts: the lower part, which was undetachable and featured two hinged inspection hatches, and the upper part comprising fifteen separate covers. The cowling also included the air duct of the coolant radiator. The rear fuselage and the wing centre section were attached to the forward fuselage by bolts and rivets. The crew and all vital assemblies of the aircraft (the engine with its associated equipment, radiators, fuel and oil tanks), as well as instruments, were housed in the armour shell manufactured from special armour steel plates with a thickness of 4, 5, 6 and 7 mm (0.157, 0.196, 0.235 and 0.274 in). Placed behind the pilot's back was an armour plate 12 mm (0.47 in) thick; the gunner was accommodated behind an armoured bulkhead 5 mm (0.196 in) thick. From the front the pilot was also protected by bulletproof glass 55 mm (2.16 in) thick; the aft-sliding cockpit canopy of the single-seat version had its sides manufactured of 3-mm (0.118-in) steel armour and an 8-mm (0.314-in) bulletproof glass panel was placed behind the pilot's head. The cockpit windshield was made of special armour glass 25 mm (1 in) thick resting on a 30-mm (1.18 in) layer of Plexiglass.

The rear fuselage was an oval-section body which tapered off into a tail cone and blended into the integrally built fin. The skin was made of *shpon* – strips of birch wood bonded together with casein glue, with each layer positioned at right angles to its neighbour for extra strength.

The fuselage had an overall length of 11.653 m (38 ft 2¾ in); according to other sources (in some production batches) it was 11.45 m (37 ft 6¾in). The maximum height of the fuselage (without the cockpit canopy) was 1.624 m (5 ft 4 in), the cross-section area was 1.76 m² (18.95 sq ft). The aircraft's height when resting on three wheels was 2.95 m (9 ft 8⅛ in), the height tail up was 4.169 m (13 ft 8⅛ in). The static ground angle was 11°55'.

Wings: Cantilever low-mounted wings of trapezoidal planform. Incidence 0°, dihedral 4°45' (3°55', according to other sources), aspect ratio 5.55. Span 14.6 m (47 ft 10¾ in), though some sources give the figure of

SPECIFICATIONS OF PROTOTYPES AND SINGLE-SEAT PRODUCTION IL-2s

	TsKB-55 (BSh-2 No.2) Prototype Plant No.39, 1940	TsKB-57 (BSh-2 No.1) Prototype Plant No.39, 1940	Production IL-2 c/n 30341 Plant No.30, 1942
Crew	2	1	1
Engine type	AM-35	AM-38	AM-38
Engine power, hp			
at take-off	1,350	1,626	1,665
at rated altitude	1,200	1,500	1,575
Length overall	11.6 m (38 ft 1 in)1	1.6 m (38 ft 1 in)	11.6 m (38 ft 1 in)
Wing span	14.6 m (47 ft 10⅞ in)	14.6 m (47 ft 10⅞ in)	14.6 m (47 ft 10⅞ in)
Wing area, m^2 (sq ft)	38.5 (414.45)	38.5 (414.45)	38.5 (414.45)
Weights, kg (lb):			
empty weight	3,615 (7,970)	3,792 (8,760)	4,016 (8,855)
fuel and oil	315+30 (695+66)	500+40 (1,102+88)	n.a.
total load	1,110 (2,450)	1,196 (2,640)	1,635 (3,605)
All-up weight, kg (lb)	4,725 (10,420)	4,988 (10,100)	5,650 (12,460)
Max speed, km/h (mph):			
at sea level	362 (225)	423 (263)	382 (237)
at rated altitude, m (ft)	422 (262) / 5,000 (16,400)	437 (272) / 2,800 (9,190)	412 (256) / 2,500 (8,200)
Landing speed, km/h (mph)	140 (87)	140 (87)	n.a.
Time to altitude, minutes:			
to 1,000 m (3,280 ft)	2.3	1.7	n.a.
to 5,000 m (16,400 ft)	11.5	10.0	16.8
Range at sea level, km (miles)	618 (384)	850 (528)	n.a.
Take-off run, m (ft)	340 (1,116)	250 (820)	470 (1,540)
Landing run, m (ft)	260 (853)	260 (853)	425 (1,395).
Offensive armament:			
Bombs, kg (lb):			
normal bomb load	400 (880)	400 (880)	400 (880)
maximum bomb load	n.a.	600 (1.320)	600 (1.320)
Cannon:	none	none	ShVAK
number x calibre, mm	–	–	2 x 20
ammunition supply, rounds	–	–	80
Machine-guns:	ShKAS	ShKAS	ShKAS
number x calibre, mm	4 x 7.62	4 x 7.62	2 x 7.62
ammunition supply, rounds	3,000	3,000	1,500
Unguided rockets:			
number x calibre	none	none	8 x RS-82
Defensive armament:	ShKAS machine-gun	none	none
number x calibre, mm	1 x 7.62	–	–

14.52 m (47 ft 7⅔ in); the wing centre section measured 4.2 m (13 ft 9⅓ in). Wing root chord (theoretical) 3.86 m (12 ft 8 in), other sources state 3.63 m (11 ft 11 in). Mean aerodynamic chord 2.876 m (9 ft 5¼ in); some sources state 2.878 m (9 ft 5⅓ in).

The wings were built in three parts: the wing centre section permanently attached to the fuselage and two outer wing panels attached to the wing centre section by means of four bolts each. The attachment bolts were made of Cromansil chrome steel alloy and underwent heat treatment. The joints between the outer panels and the wing centre section were covered by a metal strip attached by bolts. The wings utilised the Clark YH airfoil.

The wing structure comprised two spars, stringers, ribs and skinning. The wing centre section was of all-metal construction. The outer wing panels were manufactured in two versions. In the first version the wing panel had ribs, stringers and skin made of wood and plywood. The wooden framework was attached to metal spars by bolts and rivets. The skin was bonded with the help of casein glue. In the second version the wing panel had a metal frame to which a plywood skin was riveted. Two-seat aircraft of late production batches had new outer wing panels of all-metal construction, featuring an increase of the angle of sweep on the leading edge to 15° (6° more than on the preceding model).

The wings were provided with flaps; each flap was divided into two sections, one of which was fitted to the wing centre section and the other to the detachable outer wing panel. Each outer wing panel incorporated a Frise-type aileron which was divided into two sections. The inboard aileron sections were provided with geared tabs. The aileron area totalled 2.84 m^2 (30.57 sq ft), the flap area was 4.2 m^2 (45.21 sq ft). Flap settings were 45° for landing and 17° for take-off. The two-seat version had a device locking the flaps at the take-off setting of 17°. The flap setting could be monitored with the help of a mechanical indicator which was placed between the aft ends of ribs No.4 and 5 of the wing centre section on the port side.

Tail unit: The tail surfaces were of a cantilever type. The stabiliser was of all-metal construction, while the fin was made of wood. The elevator and the rudder had metal frame with fabric skinning. Control surfaces were provided with mass balances. The rudder mass balance was placed on an outrigger protruding into the airstream. The rudder had a balance tab, while the elevators had a geared trim tab.

SPECIFICATIONS OF THE TWO-SEAT IL-2 VERSIONS

	Production IL-2 c/n 1874833 Plant No.18, 1942	Production IL-2 c/n 302399 Plant No.30, 1943	Production IL-2U c/n 1876152 Plant No.18, 1943
Engine type	AM-38	AM-38F	AM-38F
Engine power, hp			
at take off	1,720	1,665	1,760
at rated altitude	1,575	1,575	1,575
Length overall	11.6 m (38 ft 1 in)	11.6 m (38 ft 1 in)	11.6 m (38 ft 1 in)
Wing span	14.6 m (47 ft 10⅞ in)	14.6 m (47 ft 10⅞ in)	14.6 m (47 ft 10⅞ in)
Wing area, m^2 (sq ft)	38.5 (414.45)	38.5 (414.45)	38.5 (414.45)
Weights, kg (lb):			
empty weight	4,427 (9,760)	4,625 (10,200)	4,300 (9,480)
fuel and oil	535+65 (1,180+143)	535+60 (1,180+143)	470+35 (1,180+143)
total load	1,715 (3,780)	1,535 (3,385)	791 (1,744)
All-up weight, kg (lb)	6,142 (13,543)	6,160 (13,583)	5,091 (11,226)
Max speed, km/h (mph):			
at sea level	370 (230)	391 (243)	390 (242)
at rated altitude, m (ft)	411 (255)/ 2,880 (9,450)	405 (252)/ 1,320 (4,330)	403 (250)/ 1,100 (3,610)
Landing speed, km/h (mph)	n.a.	136 (85)	140 (87)
Time to altitude, minutes:			
to 1,000 m (3,280 ft)	n.a.	2.2	2.0
to 5,000 m (16,400 ft)	16	15	14.8
Range at sea level, km (miles)	685 (426)	685 (426)	n.a.
Take-off run, m (ft)	498 (1,634)	370 (1,214)	385 (1,263)
Landing run, m (ft)	608 (1,995)	500 (1,640)	600 (1,968)
Offensive armament:			
Bombs, kg (lb):			
normal bomb load	400 (880)	100 (220)	200 (440)
maximum bomb load	600 (1,320)	200 (440)	
Cannon:	VYa	NS-37	none
number x calibre, mm	2 x 23	2 x 37	
ammunition supply, rounds	300	100	
Machine-guns:	ShKAS	ShKAS	ShKAS
number x calibre, mm	2 x 7.62	2 x 7.62	2 x 7.62
ammunition load, rounds	1,500	3,000	1,500
Unguided rockets:			
number x calibre	4 x RS-82	–	2 x RS-82
Defensive armament:	UB machine-gun	UB machine-gun	none
number x calibre, mm	1 x 12.7	1 x 12.7	–

The horizontal tail had a span of 4.9 m (16 ft 1 in); other sources say 4.8 m (15 ft 9 in). Its area was 7.5 m^2 (80.74 sq ft), and it had zero dihedral. The elevator had an area of 2.66 m^2 (28.63 sq ft). The vertical tail had a height of 1.9 m (6 ft 3 in) measured from the axis of the aircraft; other sources give the figure of 1.83 m (6 ft). Its area was 2.29 m^2 (24.65 sq ft); the rudder area was 1.035 m^2 (11.14 sq ft); other sources give the figure of 1.085 m^2 (11.68 sq ft).

Landing gear: Pneumatically retractable tailwheel type, with single wheel on each unit; all three units retracted aft. The main units were accommodated in underwing fairings of asymmetrical shape attached to the outer ends of the wing centre section. When retracted, the struts were enclosed by twin lateral doors; the mainwheels remained partly exposed and protruded from the fairings. The tailwheel retracted into an open recess in the rear fuselage.

The main units had twin oleo struts and 800 x 260 mm (31.5 x 10.24 in) wheels; the tail unit had a 400 x 150 mm (15.75 x 5.9 in) wheel carried on a fork mount. The wheel track was 3.5 m (11 ft 5¾ in), other sources give the figure of 3.4 m (11 ft 2 in). In comparison with the single-seat version the two-seater featured a number of changes in the detail design of the tail fork enhancing its shock-absorbing properties.

Powerplant: The single-seat IL-2 was powered by a single Mikulin AM-38 liquid-cooled 12-cylinder Vee engine rated at 1,600 hp for take-off; the two-seat version of the aircraft had an AM-38F with a take-off rating increased to 1,700-1,760 hp at 2,360 rpm and a supercharger pressure of 1,360 mm Hg. On the uprated AM-38F the OP-321 oil cooler that had been fitted to the single-seat aircraft was replaced by the OP-446 with a cooling area of 10 m^2 (107.65 sq ft).

The two-seaters were fitted with an AV-5L-158 three-bladed variable-pitch automatic propeller measuring 3.6 m (11 ft 9¾ in) in diameter; the single-seaters had a VISh-22T propeller with a diameter of 3.4 m (11 ft 2 in).

Armament: The aircraft was armed with cannon, machine-guns, bombs, unguided rockets and chemical weapons. The cannon and machine-gun armament comprised:

- two 7,62-mm (.30 cal.) Shpital'nyy/Komarnitskiy ShKAS machine-guns with a total ammunition supply of 1,500 rounds;
- two 23-mm (.90 cal.) Volkov/Yartsev VYa cannon with a total ammunition complement of 300 rounds (or two 20-mm Shpital'nyy/Vladimirov ShVAK cannon with

a total ammunition supply of 500 rounds). Installation of the ShVAK cannon instead of the VYa reduced the all-up weight of the aircraft by 135 kg (300 lb);

- a single 12.7-mm (.50 calibre) Berezin UBT machine-gun with 150 rounds of ammunition.

The UBT machine-gun was absent on the single-seat machines.

The cannon were mounted in the wing outer panels between ribs No.7 and 8 on two detachable fittings which were attached to the ribs by bolts. Ammunition was fed from ammunition boxes placed nearby via rigid chutes. The machine-guns were also installed in the wing outer panels, but between ribs Nos 6 and 7. Each machine gun was mounted on three fittings attached to the wing structure. It was fed from an ammunition box attached to the rib web.

A certain number of aircraft were armed with two Nudelman/Suranov 11-P-37 cannon (aka NS-37), each of which weighed 150 kg (330 lb) – twice as much as the VYa. One 37-mm shell weighed 735 g (1.62 lb). The muzzle velocity of the 11-P-37 was 900 m/sec (2,950 ft/sec), that is, roughly the same as that of the VYa cannon, but the rate of fire, reaching 250 rpm, was lower than that of the VYa. Mounted in underwing fairings immediately outboard of the undercarriage housings, these long-barrelled cannon had an ammunition supply of 32 rpg.

Together with the two ShKAS machine-guns which were retained for aiming, the total weight of the fixed forward-firing armament of the IL-2 armed with the 37-mm cannon, including the ammunition, amounted to 760 kg (1,676 lb). In addition to factory-produced machines, some single-seat and two-seat IL-2s armed with the 37-mm cannon were converted to this armament configuration in the field by front-line maintenance units.

The bomb armament of the two-seat aircraft provided for the carriage of a 300-kg (661-lb) bomb load internally in wing bomb bays (the normal mode) or of a 600-kg (1,323-lb) bomb load in bomb bays and on external bomb racks under overload conditions. The external bomb racks were fitted under the No.2 ribs of the wing centre section. In the case of the single-seat aircraft the bomb load amounted to 400 and 600 kg (882 and 1,323 lb) respectively. The PTAB shaped-charge anti-tank bombs weighed either 1.5 or 2.5 kg (3.3 or 5.5 lb). Containers holding up 200 of these bombs could be housed in the four bomb bays. Bombs weighing up to 15 kg (33 lb) could also be loaded directly onto the bomb bay doors; on the upper side the bomb bays had easily detachable covers. The armament included also the AZh-2 incendiary ampoules with the KS self-igniting liquid.

In addition, launching rails for the RS-82 or RS-132 rocket projectiles were mounted under the wings. Four such unguided rockets were carried by the two-seat aircraft, while the single seater could carry twice as many.

Equipment: The aircraft was equipped with the VV-1 gunsight for the pilot, a gunsight for the gunner (the K-8T sight for the UBT machine gun), as well as with the AGP-1 gyro horizon, the KI-11 compass and other instruments. In the two-seat version the pilot and the gunner communicated via the SPUF-2 intercom and with the help of a three-colour light code communication system.

IL-10 attack aircraft

The IL-10 attack aircraft destined to become a worthy successor to the IL-2 was first conceived, curiously enough, not as an attack aircraft but as a fighter. Practically in parallel with the development of the IL-2I fighter version, Ilyushin was ordered to create a single-seat armoured fighter for low and medium altitudes, which received the designation IL-1. It was to have a top speed of 600 km/h (372 mph) and possess sufficient manoeuvrability to enable active and aggressive aerial combat with the latest German fighters, the Messerschmitt Bf 109G-2 and Focke-Wulf Fw 190F-4. A directive issued by the State Defence Committee on 17th May 1943 tasked Plant No.18 (a production plant doing some prototype construction for the Ilyushin OKB as well) with producing two examples of the IL-1 armoured fighter powered by the AM-42 engine in a single-seat and a two-seat version, to be submitted for testing in July 1943. Provision for the construction of a single-seat and a two-seat version was presumably arranged by Ilyushin for the following reason. According to some sources, from the outset Ilyushin was extremely sceptical about the viability of the armoured fighter concept; he was convinced that the front was much more in need of a high-speed manoeuvrable attack aircraft. Therefore he saw to it that the IL-1 be designed with a view to ensuring not only the stipulated fighter performance but also the possibility of using this aircraft as a high-speed agile attack aircraft later on.

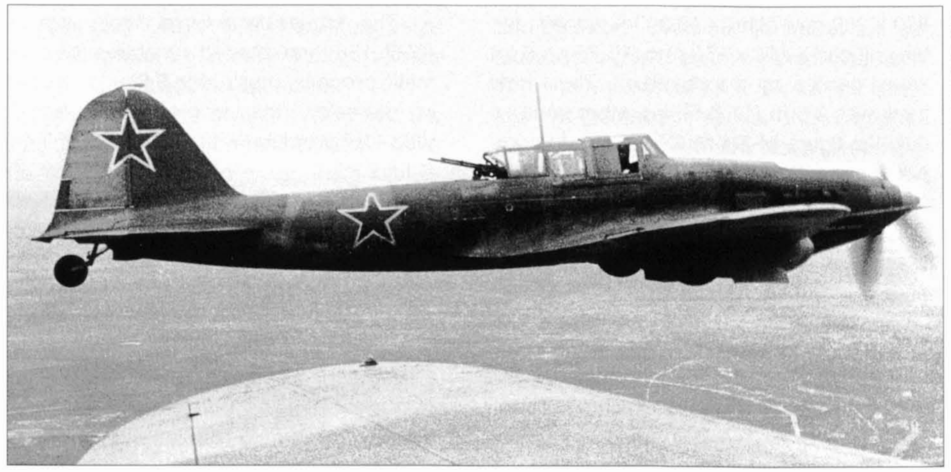
IL-1 prototype single-seat fighter

The IL-1 was designed around a new powerplant – the Mikulin AM-42 liquid-cooled V-12 engine rated at 1471 kW (2,000 hp) for take-off. The engineers obtained a high lift/drag ratio by using new wings with a higher wing loading and, accordingly, reduced area as compared to the IL-2I. The shape of the armoured body was improved by placing the water radiator and oil cooler entirely within the armoured body behind the centre section's front spar. Cooling air was supplied by two intakes in the wing roots and air ducts around the engine; after passing through the radiators it escaped through a slot on the underside of the armoured body, regulated by a hinged piece of armour plate. As a result, the fuselage contours were more streamlined than the IL-2's.

The undercarriage layout was also new. The single-strut main legs retracted aft into the wing centre section, the wheels turning 86° to lie flat, completely buried in the wings.

The armament comprised two 23-mm VYa cannon in the wing outer panels outside the propeller disc. Normally there was no provision for bombs, but 200 kg (440 lb) could be carried externally in overload configuration. To cater for the protection of the rear hemisphere, a cassette with ten AG-2 aerial grenades was carried.

On 19th May 1944 test pilot V. Kokkinaki took the IL-1 into the air for the first time. A maximum speed of 580 km/h (360 mph) was reached during manufacturer's trials. But, even before the IL-1 fighter completed its tests, Sergey Ilyushin realised it had no future. And, indeed, it was decided not to submit it for State acceptance trials. This was because the Soviet Air Force had gained air superiority in the middle of 1944 and there was no further need for an armoured fighter.



Yefim Gordon archive

This beautiful air-to-air of an IL-2 taken by the gunner of a sister ship was taken on the way home. Note the open main gear doors as the landing gear begins to extend.

IL-1 (IL-10) two-seat attack aircraft prototype

Concurrently with the work on the fighter Ilyushin had started designing a two-seat high-speed manoeuvrable armoured attack aircraft based on the IL-1's structure. Initially, the new aircraft was likewise designated IL-1 and this project was soon given the highest priority – so much so that the two-seat version actually was completed before the single-seat aircraft. Factory testing of the two-seat IL-1 began on 20th April 1944.

As on the TsKB-55 prototype, the armoured fuselage of the new attack aircraft contained not only the engine and pilot's cockpit but also the gunner's cockpit. Unlike the IL-2, the gunner was seated just aft of the pilot's armoured backrest. He was protected from the rear by an armoured bulkhead which also served as a member of the fuselage's primary structure. This compact cockpit layout avoided a great longitudinal distribution of weight, thus improving manoeuvrability and handling. The engineering team headed by Ilyushin designed a more rational system of armour, which was reinforced in the lower part of the cowling and made thinner on the sides of the cockpits. Building on operational experience with the IL-2, the engineers concluded no armour was needed on the upper forward fuselage section. This area had aluminium skins.

The IL-1 had newly developed double armouring of vital structural members, comprising two 8-mm (⁵⁄₁₆ in) armour plates with a space in between. This protected the crew not only from machine gun bullets but also from 20-mm (.78 calibre) cannon shells. In keeping with the OKB's tradition the armoured shell was integrated into the primary fuselage structure.

The IL-1 two-seat attack aircraft had the same dimensions and structural features as its single-seat precursor, but its structure was all-metal. The offensive armament was similar to that of the IL-2, comprising two 23-mm VYa guns with 150 prg and two ShKAS machine guns with 750 rpg (provision was made for an eventual replacement of the VYa canon with the 11-P37 (NS-37) cannon, but there is no evidence that such an option had ever been used). Like the IL-2, the normal bomb load was 400 kg (880 lb); in overload configuration the IL-1 could carry up to 600 kg (1,320 lb). The IL-1 had only two bomb bays (versus four on the IL-2) but they were designed so that small bombs weighing up to 50 kg (110 lb) could be loaded directly, without bomb cassettes. This speeded up the loading of bombs, reducing mission preparation time. External bomb racks were used to carry two 100-/250-kg (220-/551-lb) bombs. Four RO-82 launch rails for unguided rocket projectiles were mounted under the wings. The defensive armament was considerably increased. The IL-1 had an experimental 20-mm Shpital'nyy Sh-20 gun with 150 rounds installed in a VU-7 turret, and the tail was protected by a DAG cassette with ten 2-kg (4.4-lb) aerial grenades (a special defensive installation comprising the 20-mm BT-20 cannon was designed for the two-seat IL-1, but it was installed only at a later version)

In April 1944 manufacture of the two-seat IL-1 prototype was completed at the Kuibyshev aircraft factory's experimental shop. It was transferred for final assembly to Plant 240 in Moscow. Following the VVS's tradition of allocating even type numbers to attack aircraft and bombers, it received a new designation under which it would enter production and service, becoming the IL-10.

On 18th April 1944, after the installation of the Mikulin AM-42 prototype engine and the completion of systems tests, the IL-10 made its maiden flight with Vladimir K. Kokkinaki at the controls. Kokkinaki soon completed the initial flight tests and on 13th May the aircraft was transferred to NII VVS for State acceptance trials which lasted until 27th May 1944. The trials programme included 43 flights, most of them performed by Lt Col A. Dolgov. He was well pleased with the aircraft, noting its high stability, controllability and performance. He also stated that the IL-10's piloting techniques were no different from the production IL-2.

According to some sources, as many as three IL-10 prototypes were built and simultaneously presented for the State acceptance trials, which made it possible to complete the trials within a mere two weeks.

At a 6,335-kg (13,970-lb) AUW the IL-10 had a top speed of 507 km/h (315 mph) at S/L and 551 km/h (342 mph) at 2,800 m (9,200 ft) – 150 km/h (93 mph) greater than that of a production IL-2. It climbed to 5,000 m (16,400 ft) in five minutes versus eight minutes for the IL-2. Its service ceiling was 7,300 m (23,940 ft) and the range was 800 km (497 miles) with a 400-kg (880-lb) bomb load. Although its range was adequate and field performance was good, the take-off run was somewhat longer than the IL-2's. There were also some deficiencies, mostly concerned with the unreliability of the new AM-42 engine which obviously required a lot of development.

Generally, however, the test results proved the soundness of the concept. The optimum combination of heavy offensive and defensive armament in an armoured attack aircraft with high speed and good agility not only allowed effective multiple missions to be flown but enabled the IL-10 to

Ilyushin Aviation Complex

Ilyushin Aviation Complex

Top and above: Two views of the IL-1 heavy armoured fighter. The aircraft differed considerably from the IL-2; in fact, the forward fuselage, tail unit and landing gear design were almost identical to those of the later IL-10. The small canopy is noteworthy.

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Top, centre and above: The first prototype of the IL-10 attack aircraft seen during State acceptance trials. These views illustrate the new main gear design, the completely enclosed cockpit and the large rudder horn balance. Note that the prototype had a Shpital'nyy Sh-20 cannon in the 'ball turret'.

Russian Central National Economy Archive

Close-up of the VU-7 'ball turret' with a Sh-20 cannon.

engage all types of enemy fighters. In a fly-off between three attack aircraft types powered by the AM-42 – the Sukhoi Su-6, IL-8 and IL-10 – the latter type emerged as the winner.

A technical report on prototype construction in 1944 issued in early 1945 stated: *'In 1944 a major breakthrough was achieved in the matter of a serious improvement of the performance of our attack aircraft. The AM-42-powered IL-10 attack aircraft fully meets all the requirements and surpasses the AM-38F-powered IL-2 in speed by more than 100 km/h* [62 mph] *at sea level and by nearly 150 km/h* [93 mph] *at altitude.'*

IL-10 production attack aircraft

Series production of the type began in August 1944, but it took some time before it really gained momentum. Numerous teething troubles slowed down the tempo and even led to a short halt in production in December 1944, but after the resumption of production the output rate increased steadily. By 1st May 1945 Plants Nos 1 and 18 had delivered 785 IL-10s to the Air Force (not all of them reached the frontline units, though).

The 108th GvShAP, part of the 2nd Air Army, was the first unit to receive these formidable aircraft. Production machines differed slightly from the prototype. For instance, the experimental Sh-20 movable cannon was replaced by a production 12.7-mm (.50 calibre) Berezin UBT machine-gun and later by the Berezin UB-20 cannon. The VU-7 turret was replaced by the broadly similar VU-8 previously used on the IL-8 experimental attack aircraft.

The armament fit of the IL-10 was a subject of various upgrades and modifications in the course of its production run. For example, an order issued by NKAP on 12th February 1945 required Ilyushin to design guide rails intended for the M-13 rocket projectiles (an improved version of the RS-132 rockets) for the IL-10. Simultaneously production plants Nos 1 and 18 were tasked with launching production of these devices, so that from 20th March 1945 onwards all the IL-10s should be equipped with launch rails permitting the carriage of four RS-82s or four M-13 rockets.

Initial batches of the IL-10, as can be seen from documents, lacked dust filters (presumably because these were not needed for operations during the winter months). On 30th April 1945 NKAP issued an order requiring Plants Nos 1 and 18 to manufacture all IL-10s with dust filters of the type which had been developed and tested by Plant No.18 on an IL-10 (c/n 404). Special teams sent from these two plants were to retrofit all previously manufactured IL-10s with dust filters in a modified version, suitable for installation in field conditions.

The IL-10s were committed to action for the first time on 2nd February 1945; fighting alongside their more numerous stablemates, the IL-2s, they made their contribution to the war effort that resulted in the ultimate rout of Nazi Germany. Service pilots noted that the IL-10 had considerable advantages over the IL-2. Its wide speed envelope and better agility made it easier for escort fighters to do their job and allowed the attack aircraft to take on enemy fighters if necessary. The IL-10 was capable of steeper diving angles as compared to the IL-2 (50° versus 30°); this enhanced the effectiveness of the IL-10 as an anti-tank weapon when used by skilled pilots (diving at steep angles was beyond the capacity of young pilots).

The IL-10 made up 4% of the Soviet Air Force's attack aircraft fleet. The majority of IL-10s had been delivered to the 3rd, 15th, 16th and 8th Air Armies, all in active service at the end of the war. Before the end of the Great Patriotic War 12 Soviet air regiments converted to the IL-10; these included several regiments of the Naval Air Arm. Yet, there were also regiments, such as the 7th GvShAP that had been engaged in ground attack operations throughout the war, which received IL-10s but did not have a chance to fly a single combat sortie with them.

The IL-10s joined the action again when the Soviet Union entered the war with Japan in August 1945. They were used, among other things, for dealing strikes against Japanese ships stationed in harbours. When the war with Japan ended, all Soviet Air Force attack air regiments converted to the IL-10.

The IL-10 and its trainer version, the UIL-10 (described below), were in production until 1948, by which time 4,540 machines had been manufactured. They were supplemented by the improved IL-10M (described below) which was developed and produced on a relatively small scale in 1951-54.

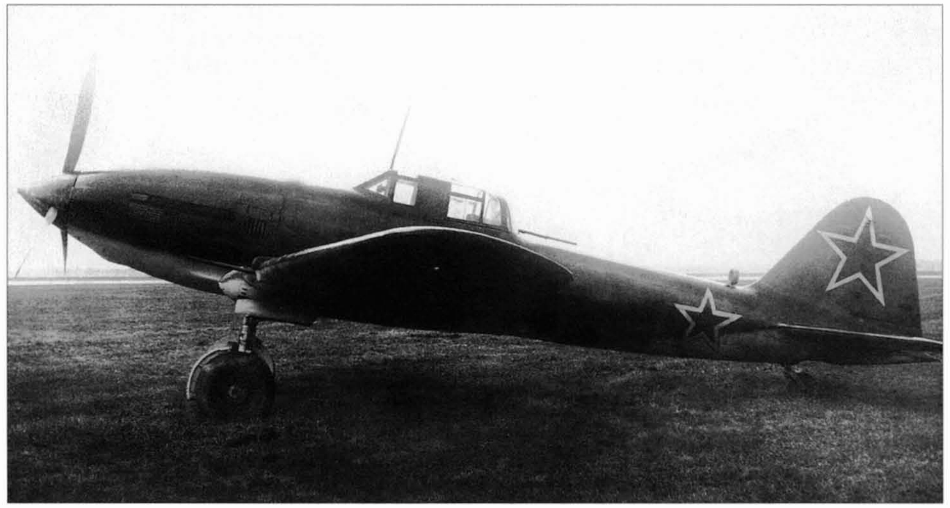
Whilst the post-war career of the IL-10 in Soviet service was uneventful, it built up a fairly prominent record in foreign service. The IL-10 came as a natural successor to the IL-2s that were on the strength of the air forces of Poland, Czechoslovakia and Bulgaria (Yugoslavia being excepted due to the conflict between Stalin and Tito). It also served with the air forces of Hungary and Romania. In addition, IL-10s were supplied to several Asian countries, namely North Korea, Communist China, Yemen and Indonesia. The North Korean and Chinese IL-10s got a chance to fire their guns in anger during the Korean war of 1951-53; the type was also involved in a local conflict in Yemen, while in Indonesia it failed to gain acceptance and was returned to Poland, the source country.

Avia B-33/CB-33 licence-built version

Among the recipient countries mentioned above Czechoslovakia distinguished itself as a country in which the IL-10 was built under licence. In accordance with an agreement reached in 1951, the Avia enterprise undertook production of the IL-10. The Czechs had a habit of giving their own designations to foreign types built in the country; thus the IL-10 was produced under the designation B-33 (*bitevní* [*letoun*] – attack aircraft), while its two-seat training version

Ilyushin Aviation Complex

Above: A pre-production IL-10 pictured during trials. Note the high-gloss surface finish, the absence of the DF loop aerial ahead of the fin and the machine gun in the 'ball turret'.



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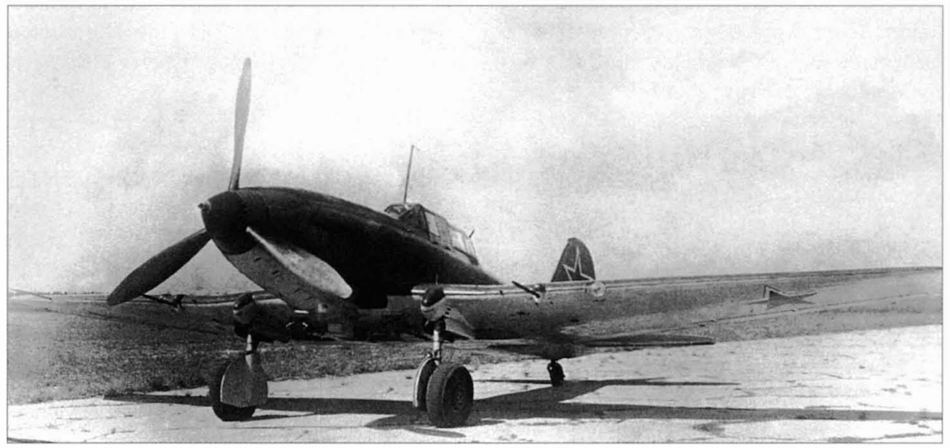
Above: An early-production IL-10 at NII VVS during checkout trials.



Ilyushin Aviation Complex

Another early-production IL-10 on the apron at NII VVS (Shcholkovo AB). The water radiator inlets in the wing roots are clearly visible.

RART

Above: An Avia B-33, the Czech licence-built version of the IL-10, in pre-1957 markings with the alphanumeric serial MW-38. The aircraft carries unguided rockets of Czech origin and is equipped with a rear gun camera.

RART

The B-33 combat version was outwardly indistinguishable from the Soviet-built IL-10.

was designated CB-33 (*cvicny bitevní* [*letoun*] – attack aircraft). It differed in some respects from its Soviet-produced counterparts and deserves a brief description.

The licence-built aircraft was armed with a quartet of 23-mm Nudelman/Suranov NS-23KM (NS-23RM, according to another source) cannon instead of two VYa cannon and two ShKAS machine-guns. The aircraft featured a VU-9M turret fitted with a 20-mm Berezin BNT-20E (B-20) cannon instead of the VU-9 turret of the Soviet-produced version. There were some other detail differences as well. In particular, the B-33s were adapted for carrying locally-designed and produced rocket projectiles. The CB-33 had a locally developed rear cockpit canopy design markedly differing from that of the Soviet-built two-seater.

Production of the IL-10 in Czechoslovakia lasted about four years and was finally discontinued in 1955, a total of about 1,200 B-33s and CB-33s having been built. They were supplied not only to the Czechoslovak Air Force but also to the air forces of Poland, Hungary, Romania and even Yemen.

The post-war history of the IL-10's development is marked by efforts to further enhance the aircraft's performance and serviceability and widen the scope of its use. Much attention was also paid to rectifying the numerous faults and defects revealed in the course of the aircraft's operational life. Steps were also taken to improve the aircraft's armament.

IL-10 with four NS-23 cannon

On 21st May 1946 NKAP issued Order No.313s tasking the Ilyushin OKB and Plant No.18 with producing a version of the IL-10 armed with four NS-23 cannon. The machine was to be submitted for factory tests by 1st September 1946.

Accordingly, the two 23-mm VYa cannon and two 7.62-mm ShKAS machine guns were replaced by four wing-mounted NS-23 cannon with 150 rpg. These newly-developed cannon had barely more than half the weight of their predecessors and their recoil was 1.6 times less, allowing a simple, light and easily serviced gun mount to be designed. They gave an increased weight of fire and higher accuracy because shell scatter decreased to between 50% and 30% of the former value. The four NS-23 cannon were supplemented by a B-20T cannon on a VU-9 flexible mount. This version saw quantity production.

IL-10 with modified bombing armament and new defensive armament

The same NKAP order envisaged the construction of a prototype IL-10 with a modified bombing armament featuring the attachment of bombs directly to the bomb shackles, without cable girdles supporting the bombs from beneath. This prototype, also featuring pneumatic control of the bomb bay doors, was to be submitted for testing at NII VVS by 15th June 1946. Another three prototypes modified as above were to feature, additionally, the new VU-9 turret equipped with the 20-mm Berezin cannon (BT-20) instead of the VU-8 turret equipped with the 12.7-mm Berezin UBT machine-gun. In November 1946 the IL-10s incorporating these features successfully passed State acceptance trials, and the modified bombing armament was introduced into series production, starting with the 30th production batch. The weapons range was expanded to include new powerful PTAB armour-piercing bombs and improved rockets capable of destroying heavy tanks and armoured vehicles. As for the VU turret with the BT-20 cannon mentioned above, this installation was first ground-tested on the IL-2 as early as January 1945, and Ilyushin suggested that this turret be introduced into series production as early as February, without waiting for the final results of the State Acceptance tests. However, it took more time than he had anticipated. The State Acceptance tests of two IL-10s equipped with these turrets (c/ns 1896306 and 105123, built by plants Nos 18 and 1 respectively) were duly conducted and completed with positive results. After the final report on the results of the tests had been endorsed on 6th September 1945, the Air Force Command issued a request for 100 IL-10s with the VU-9 turret and the BT-20 cannon to be manufactured and delivered for service tests.

IL-10U trainer

A trainer version designated UIL-10, IL-10U or IL-10UT (*oochebno-trenirovoch-nyy* – for instruction and training) was also manufactured on a small scale. Ilyushin's OKB was tasked with producing production drawings for this version in late February 1945. The first production example of the UIL-10 was submitted to NII VVS for State Acceptance tests on 16th May 1945; the tests started on 20th May and were completed with good results in early June.

The example tested was a production UIL-10 (c/n 106085) manufactured by Plant No.1. The UIL-10 had the gunner's station fitted out as a second forward-facing cockpit for the instructor. The defensive armament was deleted and the offensive armament was slightly simplified. Also deleted was the armour bulkhead between the front and rear cockpits.

The aircraft was stripped of the VYa-23 cannon but retained the ShKAS machine-guns; the DAG cassette for aerial grenades and two of the four rocket launch rails were also deleted. However, some examples had a full complement of cannon and machine-guns. In some sources the armament of the UIL-10 is stated to comprise two VYa cannon, later replaced by NS-23 cannon, and two rocket launch rails, with the ShKAS machine-guns deleted.

Some examples of the IL-10U in foreign service lacked armament altogether. Machines from different batches featured different types of rear cockpit glazing. The initial production version of the IL-10U was deficient in certain respects and required some improvements. The instructor's cockpit provided insufficient view and generally fell short of the requirements introduced in 1945. Opening and closing the cockpit canopy presented some difficulties, and the instructor lacked radio contact with the ground services. This explains the fact that Plant No.18 was tasked with presenting a modified example of the IL-10U for State acceptance trials to NII VVS by 25th June 1946. No information is available as to the nature of the modifications.

The UIL-10 was manufactured by Plants Nos 1 and 18 in Kuibyshev, the production run totalling 280 machines. Plant No.1 produced 268 of these trainers, 227 of them in 1945.

IL-10 with reversible-pitch propeller

In 1949 several IL-10s were experimentally fitted with AV-15 reversible-pitch propellers which made it possible to considerably reduce the landing run. The pilots who conducted service trials of the machines were pleased with this new feature, recommending that the new propellers be put into series production. However, the Ministry of Aircraft Industry (MAP – *Ministerstvo aviatsionnoy promyshlennosti*), as the former NKAP was called since 1947, was opposed to the idea and effectively blocked it by asserting that the use of reversible-pitch propellers during the landing run would be accompanied by increased ingestion of dust into the engine, thus curtailing its service life. As a result, the reversible-pitch propellers were consigned to oblivion.

IL-10 – target-towing version

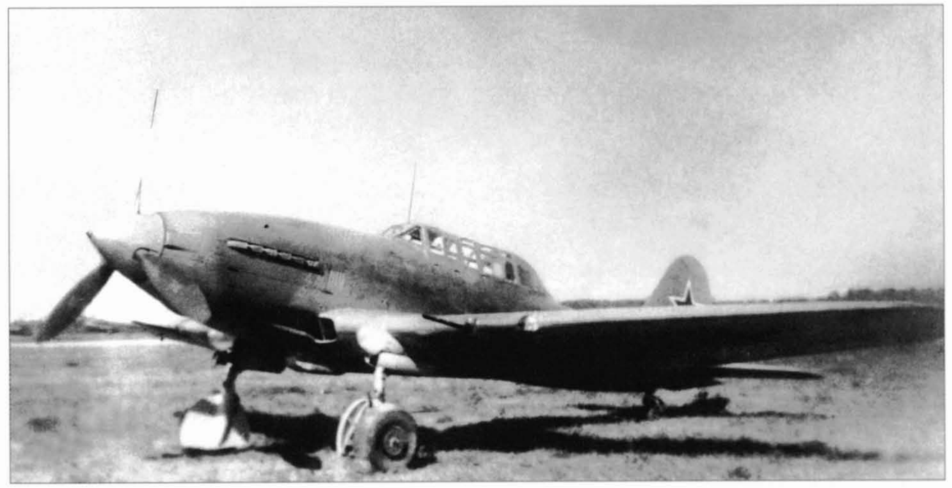
Some examples of the IL-10 were adapted for target-towing duties (the OKB was tasked with producing this version in September 1946). The IL-10s so equipped had a towing cable drum fitted under the fuselage just aft of the wings.

IL-10 – manned target aircraft

Development of this version – the Soviet counterpart of the Bell RP-63G 'Pinball' – was included into the prototype construction plan for 1946-47. Protected by appropriate armour plating, it was expected to withstand being shot at with special frangible bullets made of a lead/graphite compound. No information is available as to the result of this work.

Sergey and Dmitriy Komissarov archive

Above: This IL-10 is interesting in that it has a raked aerial mast mounted further aft and a gun camera on the defensive machine gun.

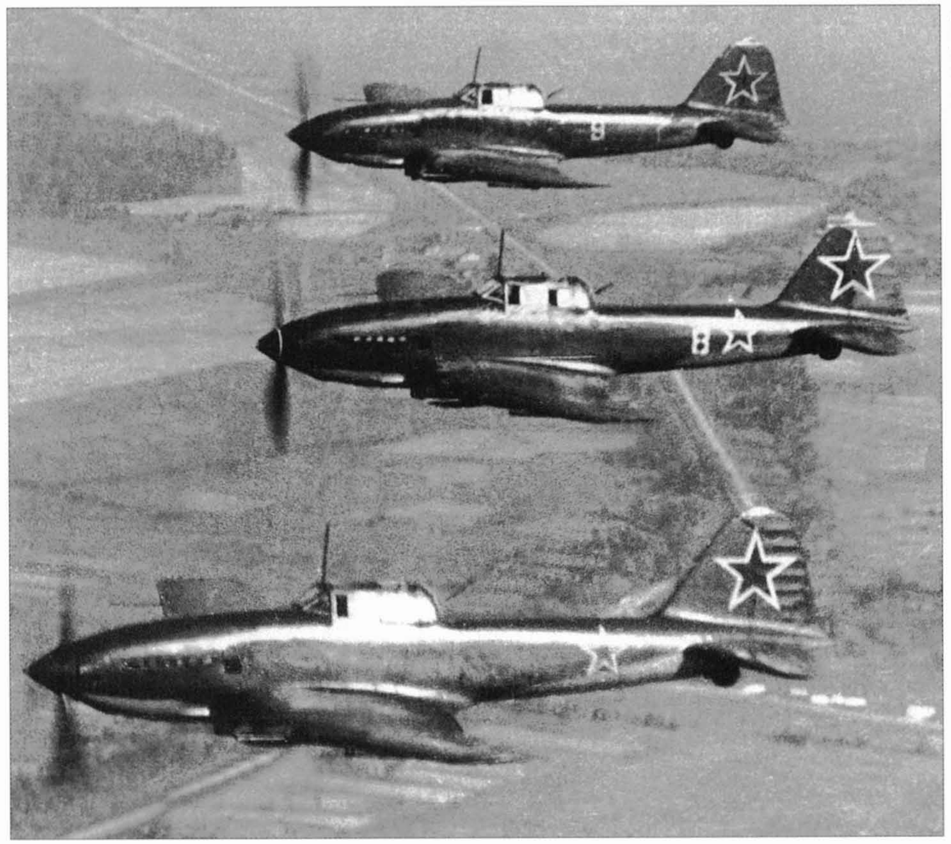


Yefim Gordon archive

The prototype of the IL-10U (UIL-10) conversion trainer at NII VVS during State acceptance trials. The redesigned cockpit canopy is clearly visible.

Yefim Gordon archive

A production UIL-10 runs up its engine on a tactical airfield. The hinged portion of the instructor's canopy has been removed.



Yefim Gordon archive

Above: Three IL-10s over the frontlines. Note how the sun brings out the structure of the rudder showing through the fabric skin.

IL-10 with AM-43 engine

The OKB was tasked with producing this version in May 1946. The AM-43 was a further development of the AM-42 engine boosted in rpm. The AM-43 engine with direct fuel injection had a take-off rating of 2,300 hp and a nominal rating of 2,000 hp at 2,300 m (7,540 ft). Order No.313 issued by MAP on 21st May 1946 stipulated that the prototype was to complete manufacturer's tests by 1st September of that year. However, on 6th September 1946 the ministry issued order No.607s which cancelled the development of the AM-43-powered version of the IL-10, citing the termination of AM-43 production as the reason. No mention is made of any prototype ever being built.

Yefim Gordon archive

Rather grim-faced Soviet Air Force pilots pose before a line-up of IL-10Ms. The picture was taken in the early 1950s, as indicated by the new style of the airmen's attire.

Curiously, some researchers have produced a somewhat different presentation of the events associated with this episode. The IL-10 powered by the AM-43 driving an AV-5L-24 propeller was allegedly built in December 1945 at plant No.18 and tested, although no record of the tests has been found. It is presumed that the tests did not proceed beyond taxying runs and hops because of unreliable engine operation. It may well be that the construction of the mentioned prototype actually did take place in December 1945 as the OKB's 'private venture' and was 'legalised' *post factum* at a later stage through a formal NKAP order.

IL-10M attack aircraft

The IL-10 was manufactured until 1948, by which time 4,540 had been built. Two years later, in 1950, when the Korean War broke out, the IL-10s operated by North Korea were flung into the fray, and their operations at the opening stage of the war were deemed quite successful. The Soviet Air Force Command came to the conclusion that the IL-10 could still be useful and should be reinstated in production. On 12th January 1951 the Soviet Government issued a directive stipulating that production of the IL-10 be organised at Plant No.168 in Rostov-on-Don. A massive redesign undertaken in this connection by the OKB resulted in the IL-10M (*moderni***zee***rovannyy* – updated). The new version differed from the IL-10 mainly in having new wings with 3 m² (32.25 sq ft) greater area and characteristically squared-off wingtips instead of rounded ones. The wings featured constant dihedral from the roots, as distinct from the original IL-10's wings with their combination of a zero-dihedral wing centre section and dihedralled wing outer panels. The horizontal tail, also altered in planform, was raised 75 mm (3 in) to move it out of the wing upwash. The area of all control surfaces was increased considerably and new slotted flaps with better lift properties were introduced. The overall length increased by 750 mm (2 ft 5½ in), starting with the second prototype (the first prototype being a kind of a transitional type, featuring the 'old' short fuselage in combination with the 'new' wings). The tailwheel was moved aft 700 mm (2 ft 3½ in).

The higher gross weight required the main undercarriage legs to be reinforced and equipped with bigger wheels. Changes were also made to the armament, the NS-23 cannon giving way to new Nudelman/Rikhter NR-23 cannon of the same calibre but with a higher rate of fire, each with 600 rpg. The bombing armament was supplemented by racks under the detachable outer wings permitting the carriage of 250-kg (551-lb) bombs and 300-litre (66 Imp gal) auxiliary fuel tanks. An electrically-powered VU-9M gun turret was installed, enabling the flexible cannon to move faster. It mounted a 20-mm BT-20EN cannon with 150 rounds.

The first production IL-10Ms displayed insufficient directional stability. Its cause was traced to gussets fitted to the rudder in order to eliminate the previously revealed self-oscillations. The fault was remedied by mounting a ventral strake beneath the rear fuselage; this strake became a standard feature of all production IL-10Ms.

One more problem surfaced in the course of the IL-10M's service introduction. Service pilots found it difficult to recover from a spin in the IL-10M. Special tests were conducted to establish the causes of the fault; it turned out that spin recovery in the IL-10M required inordinate physical exertion on the part of the pilot due to excessive control forces; steps were immediately taken to remedy the fault.

IL-10M target tug

There is evidence that the IL-10M was used for target-towing. A drum for the towing cable was mounted under the fuselage just aft of the wing; the fuselage tail cone was cut down.

IL-10M with a liquid-fuel rocket booster

One production IL-10M was experimentally fitted with a liquid-fuel rocket booster in the aft fuselage. The fuselage tail cone was cut down immediately aft of the empennage to provide an opening for the rocket motor's nozzle.

The IL-10M was in production from 1952 to 1954. During this period Plant No.168 manufactured 136 IL-10Ms (a figure of 146 is quoted in some sources).

IL-10 – Structural description

The IL-10 was a two-seat armoured ground attack aircraft. The airframe was of all-metal construction, except that all control surfaces had a fabric covering.The aircraft was provided with potent machine-gun, cannon and bomb armament; all vital assemblies and the crew were protected by armour.

Fuselage: The fuselage was built in two sections. The *forward fuselage*, which also included the cockpit, was manufactured as an armour shell made up of special armour steel plates with a thickness ranging from 4 to 8 mm (0.157 to 0.314 in). The armour shell housed all the main assemblies of the powerplant, controls and cockpits. The cockpit canopy comprised a fixed windshield with quarterlights and two hinged glazed sections for the pilot and gunner, with a crash frame in between. They hinged open to starboard, which enabled the crew to abandon

Ilyushin Aviation Complex

The IL-10M prototype at Moscow's Central airfield (Khodynka), showing the twin cannons and rocket launch rails.

the aircraft in an emergency, even in the case of a complete nose-over. The hinged glazed sections had sliding direct vision windows.

The pilot's cockpit was hermetically sealed and provided with ventilation. In addition, the pilot and the gunner were equipped with gas masks.

The pilot's seat and the gunner's tip-up seat were stamped from duralumin sheet. The gunner's cockpit was also provided with a belt seat intended for use when firing the machine-gun.

The *rear fuselage* was of metal construction; its structure was made up of frames and stringers.

To eliminate the drag caused by internal air flow within the fuselage, all openings and gaps permitting such flow were hermetically sealed; special bulkheads dividing the fuselage into sections were provided.

The rear fuselage was flush-riveted. Placed in its underside was a camera window for an AFA-IM strike camera closed by twin doors. The cut-out for the tailwheel was topped by a dome-shaped stamped duralumin cover.

The aircraft's length was 11.12 m (36 ft 6 in); according to some sources, the fuselage, that is, the aircraft as such, was 11.057 m (36 ft 3⅜ in) long. The aircraft's height tail up was 4.18 m (13 ft 1½ in).

Wings: Cantilever low-wing monoplane; dihedral 5°, incidence 2°30'. Overall span 13.4 m (43 ft 11½ in); the wing centre section had a span of 3.8 m (12 ft 5⅝ in). Overall wing area 30 m² (323 sq ft). Wing chord 3.22 m (10 ft 7 in) at the root and 1.29 m (4 ft 3 in) at the tips.

The wings were a two-spar structure comprising a centre section built integrally with the fuselage and detachable outer wings. The NACA-0018 airfoil with a thickness/chord ratio of 18% was used at the roots; further outboard it was the NACA-230 airfoil, followed by the NACA-044 (some sources say NACA-4410) airfoil at the tips. A smooth transition from the wing centre section to the fuselage was achieved with the help of small fairings. The wings were

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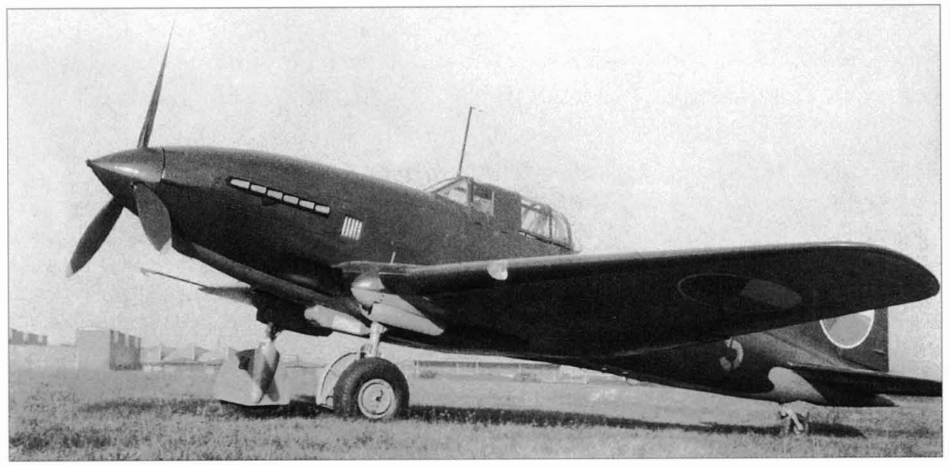
This IL-10M features a rocket booster in the cropped tailcone; a large ventral fin has been added for better directional stability.

RART

Above: V-10, a Czechoslovak Air Force CB-33 trainer. The CB-33 had a quite different canopy design from the Soviet-built UIL-10 (see page 49).

RART



Above: A new and shiny CzAF B-33. This view shows the S-shape of the colour division line near the tail which was characteristic of the Czech-built IL-10s.

RART

Above: This CB-33 serialled '6 White' is equipped with extraordinarily long missile launch rails under the wings and was probably a weapons testbed.

Squadron-Signal Publications

This Hungarian Air Force IL-10 serialled '817 White' was withdrawn from use by the time these pictures were taken (note the lack of armament). It eventually ended up in a museum.

provided with Frise ailerons and Schrenck flaps which were set 17° for take-off and 45° for landing. The flaps were attached on hinge brackets to the wing centre section and outer panels. The ailerons were 100% mass-balanced and aerodynamically balanced; their deflection angles were 22° upwards and 15° downwards. The aileron leading edges up to the spar had duralumin skin of 0.8-mm (0.031-in) thickness; the rest of the aileron frame was fabric-covered. The starboard aileron incorporated a fixed trim tab for counteracting the propeller torque. The starboard outer wing incorporated a landing light and the port one carried a pitot head. On the parked aircraft the pitot head was protected by a cover carrying a red pennant. Tie-down brackets for the snap-hooks of the arresting cables were mounted on the underside of the wing panels at the intersection of the aft spar and the No.14 rib.

Tail unit: Conventional cantilever tail surfaces. The rudder and the elevators had tubular duralumin spars, stamped duralumin ribs and fabric covering. Both elevators and the rudder incorporated trim tabs which were controlled from the cockpit. The control surfaces were 100% mass-balanced.

The horizontal tail had a span of 4.94 m (16 ft 2½ in), the stabilisers had an incidence of 1°00'. Stabiliser incidence could be adjusted on the ground within a margin of ±2°; for this purpose a special fitting was mounted on fuselage frame No.11.

The stabiliser spars were attached to the fuselage with the help of adjustable steel fittings. The joint line between the stabiliser surface and the fuselage was covered by a duralumin fairing which was attached by bolts to the fuselage and the stabiliser skinning.

The rudder had a horn balance; a mass balance was placed at the forward end of the horn.

Landing gear: Pneumatically retractable tailwheel type, with single wheel on each unit; all three units retracted aft. Wheel track 3 m (9 ft 10 in).

The main units featured single struts with 800 x 260 mm (31.49 x 10.23 in) wheels retracted into the wing centre section, the wheels turning around the struts through 86° by means of simple mechanical linkages to lie flat in the wing centre section. The mainwheel legs had folding drag struts connected to the wheel retraction mechanism. They were maintained in the extended position by downlocks placed at the centres of the folding struts; in the retracted position they were held by uplocks mounted on the wings. The 400 x 150 mm (15.74 x 5.9 in) tailwheel retracted into the fuselage.

All three units had oleo-pneumatic shock absorbers. Compression of the main unit shock absorbers was normally 40-60 mm (1½-2⅜ in), with a maximum of 200 mm (7⅞ in). The mainwheel tyres were compressed by 55-65 mm (2.16-2.56 in) and the tailwheel tyre by 35-55 mm (1.38-2.16 in).

Landing gear position was indicated by three indicator lamps and, in the case of the main units, by two mechanical indicators on the upper surface of the wing centre section. The position of the tailwheel was indicated only electrically. The mainwheel wells were closed by small twin lateral doors enclosing the oleo strut and a plate attached on the inboard side of the oleo to cover the upper two-thirds of the wheel; the tailwheel remained exposed.

A manual emergency extension system for the main units comprised a lever, a cable system and a winch mounted on the side console of the pilot's cockpit. There was no provision for emergency tailwheel extension.

Powerplant: One Mikulin AM-42 liquid-cooled 12-cylinder Vee engine with a nominal rating of 1,750 hp at sea level. The AV-5L-24 propeller measuring 3.6 m (11 ft 9¾ in) in diameter was equipped with an R-7A speed governor. Propeller blade tip clearance in the tail-up attitude was 300 mm (11⅞ in).

The engine was attached to the engine mount by 16 bolts. The gap between the exhaust stubs and the edges of the armour plates was covered by steel deflectors cut to shape. The carburettor air intake was placed under the engine cowling and provided with a shutter geared to the undercarriage; it opened when the undercarriage was retracted, permitting unobstructed passage of air, and closed when the undercarriage was extended, ensuring that the air passed through filters. Normal throttle control, boost control and operation of the fire extinguisher valve were effected by means of Bowden cables.

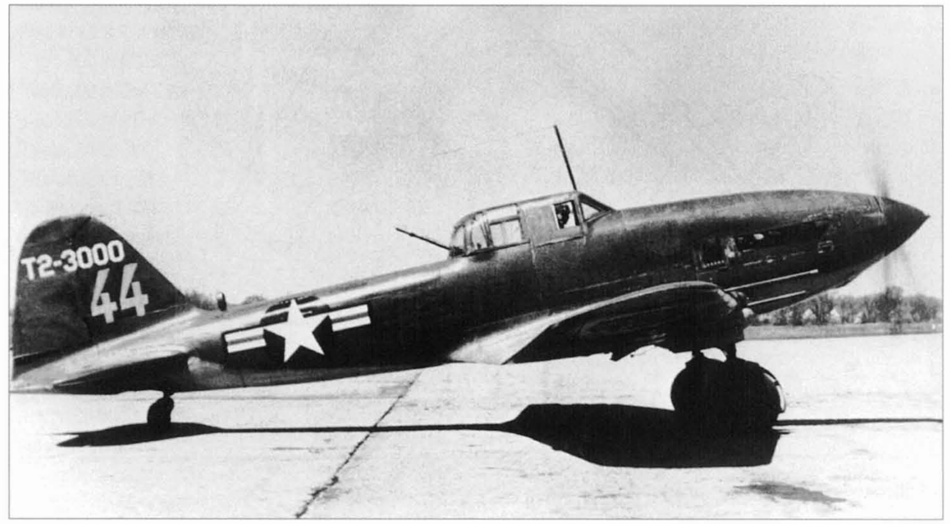
The aircraft utilised a VS-50B pneumatic engine starter system incorporating a PN-1 starter pump. The engine's cooling system comprised an expansion tank with a capacity of 20 litres (4.4 Imp gal) mounted above the engine's reduction gear, and a tubular finned water radiator installed side by side with the oil radiator. Intakes of the water radiator air ducts were located in the wing centre section leading edge either side of the engine.

Control system: The control linkages to the elevators were rigid, while the ailerons had combined rigid and cable controls; the rudder and trim tabs on other surfaces had cable controls, the rudder trim tab was electrically controlled.

USAF

Above: North Korean Air Force IL-10 '44 Yellow' was captured intact by the Americans. It is seen here at Wright Patterson AFB (Dayton, Ohio) following reassembly, still wearing its original markings.

USAF



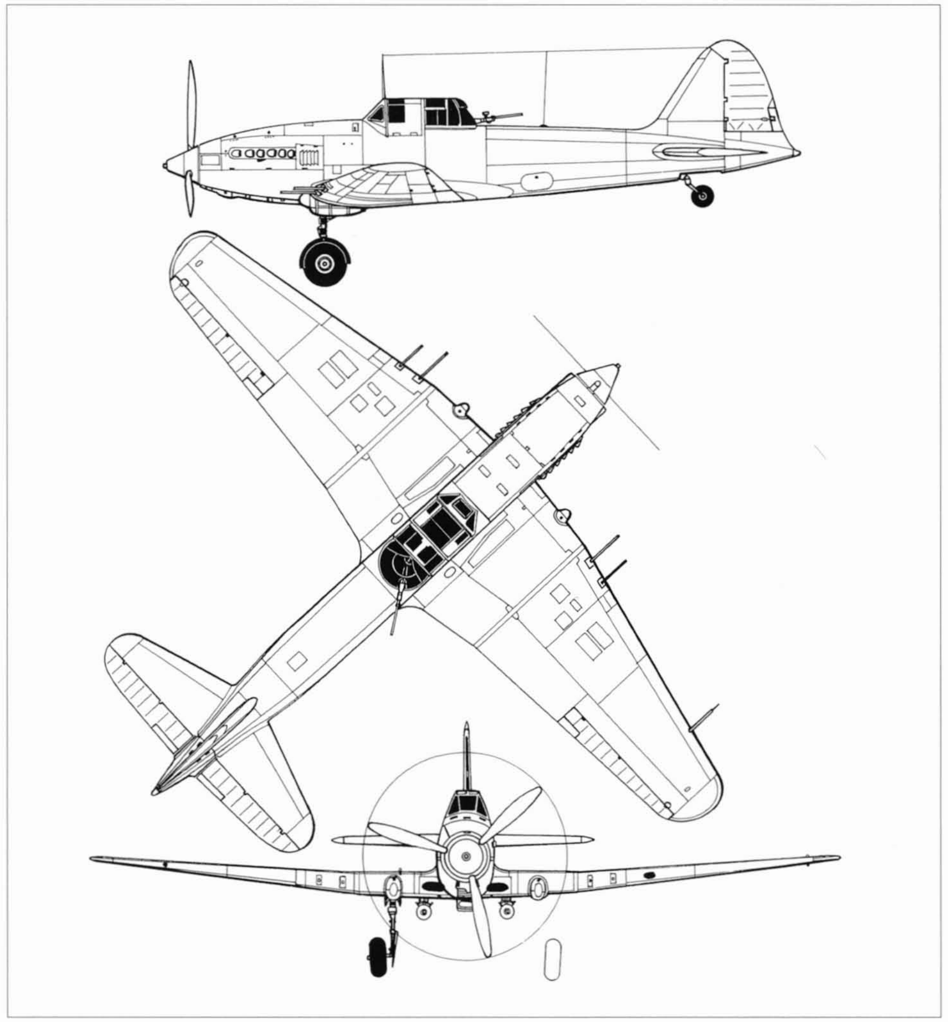
The same aircraft at Wright Patterson AFB, now wearing USAF insignia and the additional serial T2-3000 in addition to its original serial. The T stands for 'test'; such serials were allocated to captured enemy aircraft undergoing evaluation.

Fuel and oil systems: The aircraft's fuel system comprised two self-sealing fuel tanks with a total capacity of 720 litres (158.4 Imp gal). The venting of the lower fuel tank was effected through the upper tank which had an outlet into the atmosphere. A 165-litre (36.3 Imp gal) service tank was placed in the upper fuel tank.

The engine's oil supply was effected from two oil tanks placed close to the cylinder banks and connected by piping. The oil intake was effected through a pipe connected to the port oil tank. The total capacity of the oil system was 94 litres (20.68 Imp gal) – that is, 47 litres (10.34 Imp gal) in each tank. The air intake of the oil cooler duct was located in the wing centre section leading edge close to the port side of the engine cowling. The water and oil temperature was regulated by shutters mounted at the exit of the radiator ducts.

Pneumatic system: The aircraft's pneumatic system comprised two compressed air bottles (the main one and the one for starting the engine), pressure reducing regulators, undercarriage and flap control valves, shut-off valves and a non-return valve, and piping with pressure gauges. The air bottles were placed in the rear fuselage. The main air bottle's capacity was 12 litres (2.64 Imp gal) and the upper limit of its pressure was 50 kg/cm² (711 psi). The normal pressure in the air system was 40 kg/cm² (569 psi). Pressure reducing regulators, pressure gauges, undercarriage and flap control valves and shut-off valves were placed in the pilot's cockpit.

Armament: Forward-firing wing-mounted armament comprised two 23-mm (.90 calibre) VYa cannon with a total ammunition supply of 300 rounds and two 7.62-mm (.30 calibre) ShKAS machine-guns with a total complement of 1,500 rounds. The VYa cannon were mounted in the outer wing panels on two detachable fittings in a fashion similar to the IL-2's installation; the fittings were attached to the wing ribs by bolts. The machine-guns were mounted in the outer



Yefim Gordon archive

A three-view of a typical production IL-10.

SPECIFICATIONS OF THE IL-10M AIRCRAFT

	IL-10M prototype	Production IL-10M
Wing span	14 m (45 ft 11 in)	14 m (45 ft 11 in)
Length overall	11.64 m (38 ft 2 in)	11.87 m (38 ft 11⅜ in)
Wing area, m² (sq ft)	33.0 (355.24)	33.0 (355.24)
Empty weight, kg (lb)	5,588 (12,322)	5,353 (11,803)
Fuel load, kg (lb)	589 (1,300)	549 (1,211)
All-up weight, kg (lb):		
normal	7,120 (15,700)	7,100 (15,655)
overload	7,380 (16,273)	7,320 (16,140)
Maximum speed, km/h (mph):		
at sea level	475 (295)	476 (295.8)*
at rated altitude, m (ft)	516 (321)/ 2,600 m (8,530)	512 (318)/ 2,650 (8,690)
Time to altitude, min:		
to 1,000 m (3,280 ft)	2.0	2.2*
to 3,000 m (9,840 ft)	6.1	6.4*
Service ceiling, m (ft)	n.a.	7,000 (22,970)
Range at 500-m (1,640-ft) altitude with a 400-kg (880-lb) bomb load, km (miles):		
without drop tanks	830 (516)	805 (500)
with drop tanks	1,005 (625)	n.a.
Take-off run, m (ft)	n.a.	410 (1,345)
Landing run, m (ft)	388 (1,273)	500 (1,640)

* At an all-up weight of 6,875 kg (15,160 lb)

wing panels between the Nos.1 and 2 ribs. Each machine-gun was attached to the wing ribs at three points. Provision was made for replacing the wing outer panels incorporating the VYa cannon with new ones incorporating the 37-mm (1.46 calibre) 11-P (NS-37) cannon.

The firing of the wing-mounted cannon and machine-guns was controlled electrically by means of a button placed on the control stick and two switches on a panel in the cockpit. To put the weaponry into action, it was necessary first to arm the switch of either the cannon or the machine-guns and then to push the button on the control stick. Both switches had to be turned on if simultaneous firing of both types of weapons was required.

For protecting the rear hemisphere the IL-10 prototype was provided with a VU-7 'ball turret' mounting a 20-mm (.78 calibre) Sh-20 cannon with 150 rounds. Production aircraft were fitted with a VU-8 turret mounting a 12.7-mm UBK machine-gun; its ammunition supply was 150 rounds in three ammunition boxes. The VU-8 afforded the following angles of fire in the rear hemisphere: 50° upwards, 18° downwards, 45° to the left from the gunner and 55° to the right.

The defensive armament also included ten AG-2 aviation grenades in a DAG-10 container (*der**zh**atel' aviatsi**on**nykh gr**anaht***) which was installed in the aft fuselage.

For training purposes and for checking the results of gun fire in combat provision was made for the installation of the PAU-22 gun cameras on the starboard side of the UBK machine-gun mount and in the wings.

Two FAB-100 or FAB-250 high-explosive bombs of 100 kg (220 lb) and 250 kg (551 lb) calibre respectively and four RS-132 unguided rockets could be carried on external underwing shackles; the inner wing bomb bays could accommodate FAB-50 and FAB-100 bombs to a total weight of up to 200 kg (440 lb). Fragmentation and incendiary bombs weighing 1 to 25 kg (2.2 to 55 lb) apiece, as well as AZh-2 incendiary ampoules, could be placed directly on the hinged doors of the bomb bays which were retained in place by chain links connected to DER-21 shackles. The bombs were released by pushing a button on the control stick which actuated the ESBR-3P electric bomb release device. In addition, the VMSh-10 bomb release timer device could be used.

Four underwing launch rails were mounted under the outer wings. They could carry unguided rockets of the following types: 132-mm (5.19-in) RS-132 (high-explosive warhead), ROFS-132 (HE/fragmentation warhead) and 82-mm (3.22-in) RS-82 (HE warhead).

Equipment: The IL-10's equipment comprised a set of standard piloting and navigation instruments and engine gauges. These were supplemented by an RPK direction finder, an RSI-4 radio receiver, an RSI-3 radio transmitter and an AFA-IM camera for aerial photography.

IL-10M – Structural description

Fuselage: The fuselage comprised the armour shell and the rear fuselage. The forward fuselage (engine cowling) and the centre fuselage (cockpit) made up the armour shell manufactured from special armour steel plates. The cockpit canopy comprised a fixed windshield incorporating a bullet-proof windscreen, plus hinged canopy sections. The armour shell housed all the main assemblies of the powerplant, control systems and cockpits. The rear fuselage was of metal construction.

The fuselage had a length of 11.89 m (39 ft 0⅛ in), though a figure of 11.87 m (38 ft 11⅜ in) is sometimes cited; the aircraft's height tail up was 4.22 m (13 ft 10 in).

Wings: Cantilever low-mounted all-metal wings of trapezoidal planform. Wing span 14.0 m (45 ft 11 in), wing area 33.0 m² (355.24 sq ft); dihedral 4° from roots, aspect ratio 5.95, taper 2.15. The thickness/chord ratio was 18% at the root and 12% at the tips.

The one-piece slotted flaps were placed partly under the fuselage and partly under the trailing edges of the wings, occupying the greater part of the wing span. The ailerons located outboard of the flaps were fabric-covered.

Tail unit: Cantilever conventional tail surfaces with fabric-covered rudder and elevators. The stabiliser incidence could be adjusted on the ground. The horizontal tail had a span of 4.94 m (16 ft 2½ in) and an area of 6.6 m² (71 sq ft); it had zero dihedral. Vertical tail area was 2.29 m² (24.65 sq ft).

Landing gear: Pneumatically retractable tailwheel type, with single wheel on each unit; all three units retracted aft. The wheels had the following dimensions: mainwheels, 900 x 300 mm (35.43 x 11.81 in), tailwheel, 400 x 150 mm (15.75 x 5.9 in). The wheel track was 3.26 m (10 ft 8⅜ in).

Powerplant: One Mikulin AM-42 water-cooled Vee-12 engine with a nominal power rating of 1,750 hp at sea level. The AV-5L-24, measuring 3.6 m (11 ft 9¾ in) in diameter had a speed governor.

Fuel system: The fuel was housed in two fuselage tanks with a total capacity of 800 litres (176 imp gal). Additionally, a total of 300 litres (66 Imp gal) was housed in two underwing drop tanks.

Equipment: Electric equipment comprised a GSK-1500 generator and a 12A-30 storage battery. The radio equipment comprised an RSIU-3M VHF radio, an ARK-5 automatic direction finder, an MRP-48P marker beacon receiver, an RV-2 radio altimeter, an SPU-2 intercom and a Bariy-M IFF transponder.

The aircraft's navigation equipment enabled the IL-10M to operate in all weather conditions and at night.

The photographic equipment consisted of an AFA-BA/21 camera in the rear fuselage.

Armament: Cannon armament comprised four 23-mm (.90 calibre) NR-23 cannon in the wings (two in each wing panel) and one rearward-firing 20-mm (.80 calibre) B20-EN cannon on a flexible mount in the gunner's cockpit. The total ammunition complement for the NR-23 cannon was 600 rounds, the B20-EN was provided with 150 rounds.

The pilot had a PBP-1B gunsight, the gunner was provided with an OMP-13S gunsight. Bombs could be carried in the following combinations:

2 x FAB-250	18 x AO-15
6 x FAB-100	54 x AO-10
8 x AO-25-35	190 x AO-2.5
152 x PTAB-2.5	

Bombs could be carried externally on shackles under the wing centre section (for bombs weighing up to 100 kg/220 lb) and on two shackles under the outer wing panels (these were suitable for bombs weighing up to 250 kg/551 lb, or for UKhAP-250 chemical warfare liquid dispensers, or for drop tanks). Four launch rails for unguided rockets could be mounted under the wings.

SPECIFICATIONS OF THE IL-10 AIRCRAFT

	IL-10 prototype State acceptance trials 27.05.1944	Production IL-10 c/n 1894915 9.1945	Production IL-10 c/n 106085 6.1945
Crew	2	2	2
Engine type	AM-42	AM-42	AM-42
Power:			
maximum, hp	2,000	2,000	2,000
nominal at rated altitude, hp	1,750 hp	1,750 hp	1,750 hp
Length overall	11.12 m (36 ft 6 in)	11.12 m (36 ft 6 in)	11.12 m (36 ft 6 in)
Wing span	13.4 (43 ft 11½ in)	13.4 (43 ft 11½ in)	13.4 (43 ft 11½ in)
Wing area, m² (sq ft)	30.0 (323)	30.0 (323)	30.0 (323)
Empty weight, kg (lb)	5,050 (11,135)	4,723 (10,414)	4,571 (10,079)
All-up weight, kg (lb)	6,335 (13,969)	6,385 (14,079)	5,680 (12,524)
Maximum speed:			
at sea level, km/h (mph)	507 (315)	493 (306)	502 (312)
at altitude, km/h (mph)/m (ft)	551 (342) / 2,800 (9,190)	543 (337) / 2,600 (8,530)	560 (348) / 2,500 (8,200)
Landing speed, km/h (mph)	148 (92)	149 (92.6)	145 (90)
Time to altitude, minutes:			
to 1,000 m (3,280 ft)	1.6	n.a.	1.5
to 3,000 m (9,840 ft)	5	5.8	4.8
to 5,000 m (16,400 ft)	9.7	n.a.	9.6
Range, km (miles)	800 (497)	n.a.	n.a.
Take-off run, m (ft)	475 (1,560)	470 (1,540)	485 (1,590)
Landing run, m (ft)	460 (1,510)	n.a.	520 (1,700)
Offensive armament:			
bomb load, kg (lb):			
normal	400 (880)	400 (880)	200 (440)
maximum	600 (1,320)	600 (1,320)	n.a.
cannon:			
number x calibre, mm	2 x 23, VYa-23	2 x 23, VYa-23	2 x 23, VYa-23
ammunition, rounds	300	300	300
machine-guns:			
number x calibre, mm	2 x 7.62, ShKAS	2 x 7.62, ShKAS	2 x 7.62, ShKAS
ammunition, rounds	1,500	1,500	1,500
unguided rockets:			
number x type of launchers	4 x RS-82 (RS-132)	4 x RS-82 (RS-132)	4 x RS-82 (RS-132)
calibre, mm (in)	82/132 (3.22/5.19)	82/132 (3.22/5.19)	82/132 (3.22/5.19)
Defensive armament:			
number x calibre, mm	1 x 20, Sh-20	1 x 12.7, UBK	–
ammunition, rounds	150	150	–
AG-2 aviation grenades, number	10	10	–

IL-16 attack aircraft

The high performance of the IL-10 attack aircraft and its ability to engage in active air-to-air combat prompted the development of a lightweight attack aircraft with still greater speed and manoeuvrability. Design work began in 1944 and the aircraft was designated IL-16.

The IL-16 was to be powered by the new Mikulin M-43NV (AM-43NV) liquid-cooled engine with direct injection delivering 2,300 hp (1,691 kW) for take-off. Aerodynamically and structurally, the IL-16 was virtually identical to the IL-10 but had slightly smaller dimensions and weight. Coupled with the more powerful engine, this was expected to give the new attack aircraft a top speed of 625 km/h (388 mph) at 3,400 m (11,150 ft) and 560 km/h (348 mph) at sea level. Other design performance figures included a ceiling of 9,000 m (29,530 ft), a range of 800 km (497 miles). These figures and those quoted in brackets below were mentioned in NKAP order No.43ss dated 6th February 1945.

The IL-16's armour protection was similar to that of the IL-10, but the armour plate thickness of the engine cowling sidewalls and the cockpit section sidewalls was reduced. Besides, the upper front part of the fuselage had larger 'soft-skinned' areas.

The aircraft's forward-firing offensive weapons comprised two NS-23 cannon with 280 [300] rounds and two ShKAS machine guns with 1,400 [1,000] rounds installed in the detachable outer wings.

Originally the IL-16 was to have a 200-kg (440-lb) normal bomb load and a 400-kg (880-lb) maximum bomb load, the bombs being carried internally (in two bays in the inner wings) and externally on underwing racks. Later, however, it was decided to increase the normal bomb load to 400 kg and the maximum bomb load to 500 kg (1,100 lb). The rear hemisphere was protected by a turret-mounted UB-20 cannon with 150 rounds and by ten AG-2 aviation grenades.

Thus, according to the project, the IL-16 attack aircraft was virtually equal in firepower to the IL-10 while having markedly superior speed and manoeuvrability. The front-line units needed such an aircraft, and preparations for series production began even before the IL-16 prototype entered flight test.

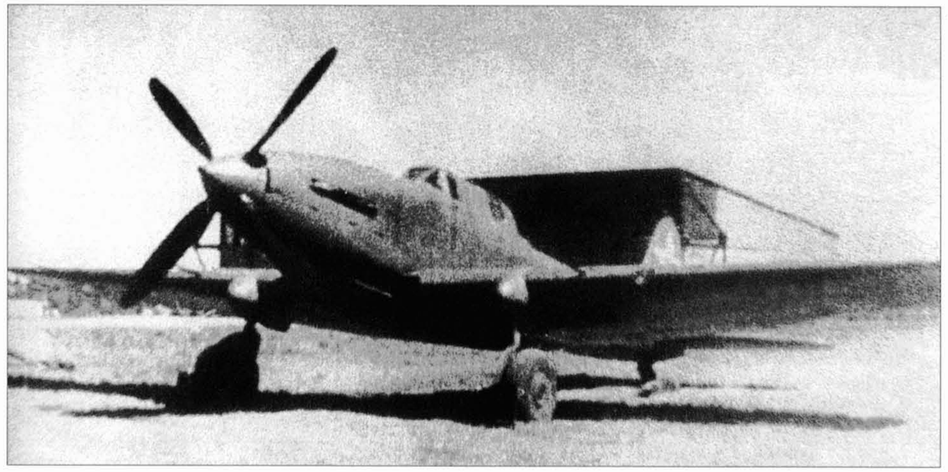
The first IL-16 prototype. was completed by one of the production plants – Plant No.18 – in early 1945, while Plant No.240 (the Ilyushin OKB) had performed the project work on the aircraft. Three prototypes were built, according to some sources. There is a document stating that Plant No.39 (No.30?) was tasked with building an IL-16 prototype with the AM-43 engine; the aircraft was to be submitted for factory tests on 15th June 1945. That was stipulated by the order No.43ss issued by the People's Commissariat of the Aircraft Industry on 6th February 1945. The order contained design performance figures (specifications) with revised figures for the bomb load – 400/500 kg. It is not clear whether this was an order for yet another example of the IL-16 and whether it was actually built.

The IL-16 was test flown – as the reader has surely guessed – by Vladimir K. Kokkinaki. It was immediately apparent that the torque of the very powerful engine, combined with a short rear fuselage, resulted in unsatisfactory longitudinal stability characteristics. To improve these the detachable aft fuselage was lengthened by 500 mm (1 ft 7¾ in), vertical tail area was increased and the rudder was provided with a trim tab. With these modifications the aircraft became more stable and controllable in flight. Nevertheless, flight testing of the IL-16 proved to be a protracted affair because of the M-43NV engine's deficiencies. All attempts to rectify them failed, and in the summer of 1946 the development of the IL-16 was terminated.

IL-16 SPECIFICATIONS

Year of manufacture	1945
Crew	2
Engine type	AM-34NV
Engine power at take-off, hp	2,300
Empty weight, kg (lb)	4,135 (9,118)
All-up weight, kg (lb):	
normal	5,780 (12,745)
overload	5,980 (13,190)
Total load, kg (lb)	1,465 (3,230)
Maximum speed, km/h (mph):	
at sea level	529 (329)*
at rated altitude	576 (358)*
Range, km (miles)	800 (497)
Take-off run, m (ft)	400 (1,310)
Offensive armament:	
machine-guns	2 ShKAS 7.62 mm
cannon	2 VYa 23 mm
Bomb load, kg (lb):	
normal	400 (882)
maximum	500 (1,102)
Defensive armament:	
cannon	1 x 20mm
AG-2 aircraft grenades	10

*These figures were obtained with a derated engine possessing lower altitude performance


Ilyushin Aviation Complex

Above: The first prototype of the IL-16 attack aircraft.


Ilyushin Aviation Complex

The second prototype IL-16 differed in having an extended rear fuselage and a taller fin.

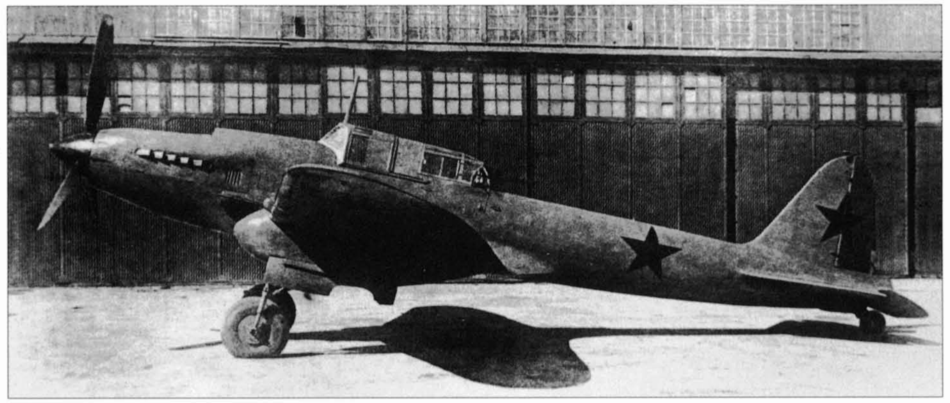
BSh M-71 (IL-8 M-71) project

Ilyushin's first attempt at creating a single-engined heavy attack aircraft was connected with the use of a different engine – namely the 2,000-hp Tumanskiy M-71 air-cooled radial. In August 1942 Ilyushin submitted a proposal for creating a heavy armoured attack aircraft powered by this engine; it was initially designated BSh M-71. It was a two-seat aircraft with the forward-firing armament comprising two 37-mm NS-37 cannon and two ShKAS machine-guns; project work on it was completed by July 1942. Its design performance included a maximum speed of 430 km/h (267 mph) at sea level, which was a considerable improvement on the AM-38-powered IL-2. In September 1942 Air Force C-in-C A. A. Novikov suggested to People's Commissar of Aircraft Industry A. I. Shakhurin that the BSh M-71 be included into the prototype construction plan for 1942, the target date for State Acceptance trials being 1st March 1943. However, it was not before August 1943 that Ilyushin was in a position to present an advanced development project of the aircraft, which by then was renamed IL-8 M-71 (first use of the IL-8 designation).

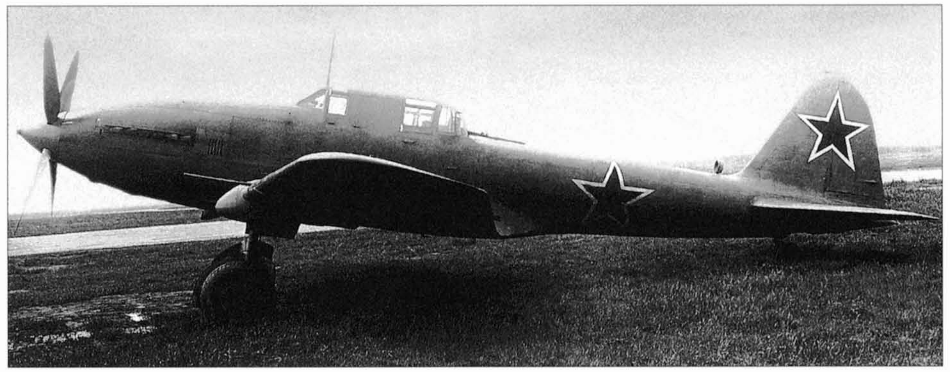
Unlike the IL-2 M-82, the radial engine on this aircraft was to be completely enclosed by a cowling made of suitably shaped armour plating; it formed part of an armour shell extending further aft to protect both the pilot and the gunner. The protection afforded to the gunner was especially noteworthy: in addition to the side, rear and ventral armour plating of his cockpit, the gunner was enclosed by a dome-shaped metal turret made mostly of armour steel and partly of bulletproof glass to provide the necessary view. The aircraft's design performance was considered promising by specialists who were also impressed by the degree of protection from the rear hemisphere. Yet, the project was not given the go-ahead. This may have been due, at least in part, to difficulties encountered in the development of the M-71 engine with its numerous teething troubles.

IL-2 AM-42 attack aircraft prototype

The work on creating a heavyweight attack aircraft powered by the AM-42 engine was preceded by attempts to effect a straightforward adaptation of the IL-2 airframe to this powerplant. The new Mikulin AM-42 was an updated AM-38F rated at 2,000 hp (1,492 kW) for take-off and providing 1,770 hp (1,320 kW) at 1,600 m (5,250 ft). By comparison, the AM-38F delivered 1,700 hp/1,268 kW for take-off and 1,500 hp/1,119 kW at 750 m (2,500 ft). In September 1942 Ilyushin's OKB and production plant No.18 were tasked with the design and manufacture of two updated versions of the IL-2 based on the use of the AM-42 which was then still in prototype form. These two machines, sometimes referred to collectively as IL-2 AM-42, differed in a number of respects. The first of them was known as the IL-2 AM-42 with refined aerodynamics, or S-42. It featured increased sweepback on the outer wing leading edges, increased-area elevator aerodynamic balance, an improved external finish, a retractable tailwheel, an extended armour shell protecting both crewmembers, re-stressed wings and some other refinements. This machine was under construction, but the work on it was not completed due to difficulties with the AM-42 engine.


Ilyushin Aviation Complex

Above: The first prototype IL-AM-42 (IL-8) attack aircraft seen during manufacturer's flight tests; it was extremely similar in appearance to the standard IL-2. Note the fully enclosed cockpit.


Ilyushin Aviation Complex

The second version powered by the AM-42 engine was the much-redesigned IL-8 'Mk II'. The first of two prototypes is seen here at NII VVS during State acceptance trials. Note the four-bladed propeller, the IL-10 style main landing gear and canopy design; the vertical tail, however, is still similar to the IL-2's, lacking a rudder horn balance.

IL-2M AM-42 attack aircraft prototype

The second prototype aircraft was designated IL-2M AM-42; this was a variant reflecting the concept of a heavy attack aircraft. It had somewhat bigger dimensions compared to the IL-2 AM-38F, and its normal bomb load was increased to 500 kg (1100 lb). The IL-2M incorporated many of the refinements introduced on the S-42; a special feature of the IL-2M was the armour-plated dome-shaped turret of the same type as on the IL-8 M-71. Testing of this aircraft commenced in August 1943 at Plant 240 in Moscow to which Ilyushin's OKB was transferred from the manufacturer – Plant No 18. In the course of testing the armour-plated turret revealed its shortcoming – a very restricted field of view for the gunner – and was replaced first by a normal glazed turret and then by a flexible mount of the type used on the IL-2 AM-38F. The IL-2M's performance was significantly better than that of the IL-2 AM-38F, which was in no small part due to the new propeller measuring 4 m (13 ft 1½ in) in diameter; however, it caused engine vibration and had to be replaced by a propeller of 3.6 m (11 ft 10 in) diameter with which the aircraft's performance dropped almost to the level of the AM-38F-powered aircraft. The IL-2M AM-42 remained a prototype and was used chiefly for flight-testing the new AM-42 engine. The concept of a heavy attack aircraft was implemented by Ilyushin on another AM-42-powered machine.

IL-8 (IL AM-42, IL-8-I) heavy attack aircraft

In the summer of 1942 Sergey Ilyushin received a request for a proposal for a heavy attack aircraft with a bomb load of up to 1,000 kg (2,205 lb). It was prompted by the need to inflict as heavy losses as possible to the enemy's motorised infantry on the offensive by means of air attacks. Building on

Russian Central National Economy Archive

Above: The second IL-AM-42 at NII VVS during State acceptance trials. The revised canopy design and the new-style insignia clearly visible.

Russian Central National Economy Archive

The gunner's station of the first IL-8 equipped with a Berezin UB-20 cannon.

Russian Central National Economy Archive

The gunner's station of the first IL-8 equipped with a Berezin UB-20 cannon.

combat experience with the IL-2, Ilyushin chose a single-engined configuration. The projected aircraft was essentially a scaled-up IL-2 with better armour protection, longer range and the same armament. While retaining a broad similarity of general layout, basic contours and many design features to those of the IL-2, the new machine was structurally a completely new aircraft of bigger dimensions.

Originally known as IL-AM-42, the aircraft was allocated the factory designation IL-8. Some refinements were introduced into the aircraft's aerodynamics. The oil cooler was accommodated side-by-side with the coolant radiator in a duct similar to that of the IL-2, with a characteristic big air scoop on top of the engine cowling. The size of the scoop was enlarged and it was moved slightly aft, closer to the cockpit. The IL-8 featured enhanced armour protection. As distinct from the IL-2, the gunner's cockpit was accommodated within the confines of the armour shell. The latter had bigger dimensions and featured thicker plates in the most vulnerable areas. Accordingly, the weight of the armour plating rose by 150 kg (330 lb).

The rear fuselage was lengthened by 1.25 m (4 ft 1 in) to enhance the effectiveness of the empennage. To allow for the greater diameter of the propeller, the main undercarriage legs were lengthened and the underwing undercarriage fairings were modified accordingly. The gunner's station was provided with a 12.7-mm UBK machine-gun. Forward-firing armament of the IL-8 comprised two VYa-23 cannon with a total of 300 rounds and two ShKAS machine-guns with 1,500 rounds. As an option, two NS-37 cannon could be installed in the wing instead of the VYa cannon. (Actually, the first version of the IL-8 was built in two examples, one of which was armed with VYa cannon while the other one was fitted with NS-37s). In addition, a static test airframe was built with some delay.

Two versions of the aircraft were under design concurrently. Alongside with the baseline attack/bomber version design work was started on a reconnaissance/artillery spotter aircraft with a slightly shorter range but with more efficient radio communications equipment.

The IL-8 prototype took off on 10th May 1943. Project test pilot Vladimir Kokkinaki said the aircraft was easy to fly and gave no surprises. At a weight of 15,983 lb (7,250 kg), the IL-8 had a top speed of 270 mph (435 km/h) at sea level and 292 mph (470 km/h) at 7,400 ft (2,240 m) – almost 31 mph (50 km/h) faster than a production IL-2 at low altitudes. Climb rate increased by 15% and range was almost doubled. Thanks to the powerful engine the take-off run was only 318 m (1,043 ft), while landing speed was 132 km/h (82 mph). On the down side, the tests were delayed by engine problems; the AM-42 proved unreliable, smoky and plagued by vibration. Still, the IL-8 powered by the AM-42 with an AV-5L-18B propeller underwent State Acceptance trials that lasted from 26th February to 30th March 1944. The first prototype performed 44 flights, logging 19 hours 30 minutes; it was tested in two versions: an attack aircraft/bomber and a reconnaissance/spotter aircraft. The results were considered generally satisfactory, and the aircraft was recommended for production in both versions, provided all the problems were solved.

Ilyushin states in his report to NKAP on the OKB activities in 1944 that *'the IL-8-2 AM-42* (presumably the second example of the original IL-8 – authors' note) *was flyable as per 1st January 1944; it passed factory testing during the first quarter of 1944 and was submitted for State Acceptance trials on 29th March 1944 instead of 1st April, ie, three days earlier than stipulated.'* State acceptance trials of the second example were completed on 27th May 1944. (It should be remarked here that the designation IL-8-2 was, rather confusingly, used in documents and literature to denote both the second example of the original IL-8 and the later, reworked version of the IL-8).

The first and second examples of the IL-8 differed in having different rear fuselages: the first one had a rear fuselage of wooden construction, while the second aircraft had an all-metal fuselage. The first example was armed with two VYa-23 cannon, two ShKAS machine guns and one movable UBK machine-gun in a VU-8 turret while the second example had two 37-mm 11-P37 cannon instead of the VYa.

The document summarising the results of the State Acceptance trials of the IL-8 was endorsed on 12th April 1944. On 5th May Red Army Air Force Chief Engineer A. K. Repin wrote to G. M. Malenkov and A. I. Shakhurin, asking them to consider the issue of immediately putting this aircraft into series production at Plants Nos 1, 18 and 30; he suggested that 30 aircraft be manufactured in the attack version and ten in the artillery spotter version by 15th July 1944. Another document shows that at one moment Shakhurin envisaged the prospect of the IL-8 supplanting the IL-2 completely on the production lines. On 18th May 1944 he sent to Malenkov a draft resolution of the State Defence Committee ordering IL-8 production to be launched at Plant No.18.

However, these plans never materialised. This was presumably due to some shortcomings of the new machine which made its service introduction a questionable affair. Indeed, while the IL-8's speed and range performance was a marked improvement on the IL-2 AM-38F, the new aircraft's manoeuvrability in the horizontal and vertical planes proved to be inferior to those of the IL-2 and fell short of the current battlefield requirements.

IL-8 attack aircraft – a reworked version (IL-8-2)

By the end of the IL-8's test programme the OKB had achieved good progress with the IL-1 (IL-10) described above. Hence Sergey V. Ilyushin proposed redesigning the IL-8's engine cooling and lubrication system, armour shell, wings, undercarriage and empennage to match those of the IL-1. This proposal was made by Ilyushin in a letter to Shakhurin dated 1st July 1944. An NKAP order to this effect was issued on the same day. All the experience gained by the OKB was used to improve the aircraft. Thus, despite having the original IL-8 designation, the resulting aircraft emerged as a completely new machine. Externally it resembled very much the IL-10 from which it differed in having a longer fuselage and a four-blade propeller. A feature shared by the IL-10 and the new IL-8 variant was the sleek shape of the engine cowling which dispensed with the huge air scoop on the top; instead, two ducts placed on either side at the junction of the wing and the fuselage were used as air intakes for the coolant and oil radiators.

The IL-8 in its new guise featured a somewhat different armament fit. The VYa wing cannon were replaced by NS-23s. The machine-gun in the rear cockpit was replaced by the more potent UB-20 cannon on the VU-9 flexible mounting. Defence of the rear hemisphere was further enhanced by a cassette with ten AG-2 aerial grenades in the rear fuselage. Modified bomb bays enabled the aircraft to carry internally a bomb load of up to 1,000 kg (2,205 lb) versus 600 kg (1,323 lb) in the first IL-8 version. Alternatively, two 500-kg (1,102 lb) bombs could be carried externally on bomb racks.

Changes were introduced into the armour plating as compared to the first version of the IL-8. In particular, the pilot and the gunner were protected from the rear hemisphere by an armour bulkhead comprising two spaced layers, each of 8 mm (0.31 in) thickness.

The redesign was effected in July 1944 and prototype conversion was completed in August and September. The revamped IL-8 (sometimes referred to as IL-8-2) made its first flight on 13th October – again with Kokkinaki at the controls. Once again the test programme lagged behind schedule due to powerplant problems – testing was suspended on 18th December 1944 due to the poor condition of the engine. The new AV-9L-22B four-bladed propeller was also the culprit this time, causing severe vibration during early test flights. However, this problem was solved just before the State Acceptance trials began shortly after the end of the war, on 27th May 1945; they were completed on 7th July. Several types of propellers had to be tested consecutively before normal operation was finally achieved with the four-blade AV-5L-22B airscrew.

Reports of the test pilots were generally favourable. They gave due credit to the new aircraft's good stability and ease of handling, high load-carrying capacity, potent armament and good serviceability. The performance figures also showed some improvement as compared to the previous type. The new arrangement of the water radiator and oil cooler, the more streamlined shape of the armoured fuselage (reminiscent of the IL-10) and other improvements increased speed to 286 mph (461 km/h) at S/L and 316 mph (509 km/h) at 9,200 ft (2,800 m) at an AUW of 16,766 lb (7,610 kg). Still, the performance of the modified IL-8 was inferior to that of the IL-10 which had already entered service. In addition, some shortcomings revealed during the State Acceptance tests had to be rectified. However, this proved inexpedient.

When NII VVS project test pilot Colonel A. Dolgov and engineer S. Frolov submitted the IL-8's State Acceptance trials report, the Soviet Air Force First Deputy C-in-C Vorozheykin wrote (on 14th August 1945): *'Further development of the IL-8 is inexpedient because the IL-10, which outperforms it, is in production and the IL-16 is forthcoming.'* (The latter aircraft is described below. As will be seen, the IL-16 did not justify the hopes pinned on it, unlike the IL-10 which became the mainstay of the Soviet Air Force's attack air units.)

Sergey Ilyushin agreed with this decision; yet, for some time he cherished the idea of prolonging the life of the IL-8 by re-engining it with the more powerful AM-43 engine – a further development of the AM-42 featuring direct fuel injection. The prototype aircraft construction plan for 1945 envisaged the construction of an IL-8 derivative powered by the AM-43 delivering 2,300 hp at take-off and 2,000 hp at the rated altitude of 2,300 m (7,550 ft). There is no documentary evidence as to whether this aircraft was actually built; in all probability, this project was abandoned due to difficulties experienced with the AM-43 development (the same fate befell the projected AM-43-powered version of the IL-10).

Nevertheless, this was not Ilyushin's last piston-engined attack aircraft. Two years later Ilyushin's design bureau brought out the IL-20 heavy armoured bomber and attack aircraft which incorporated the designers' accumulated experience. This aircraft is described later.

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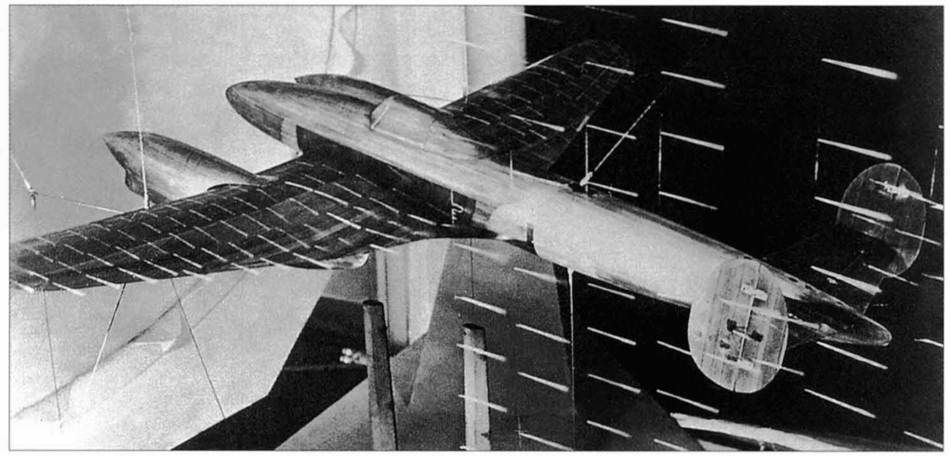
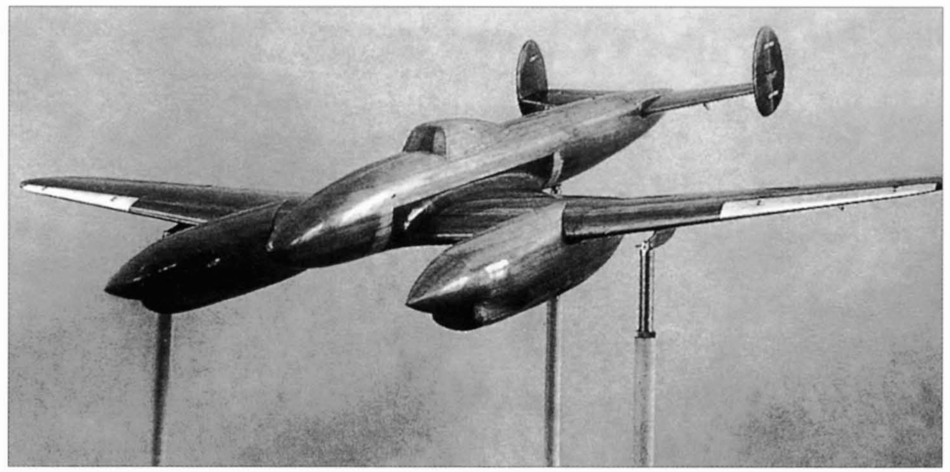
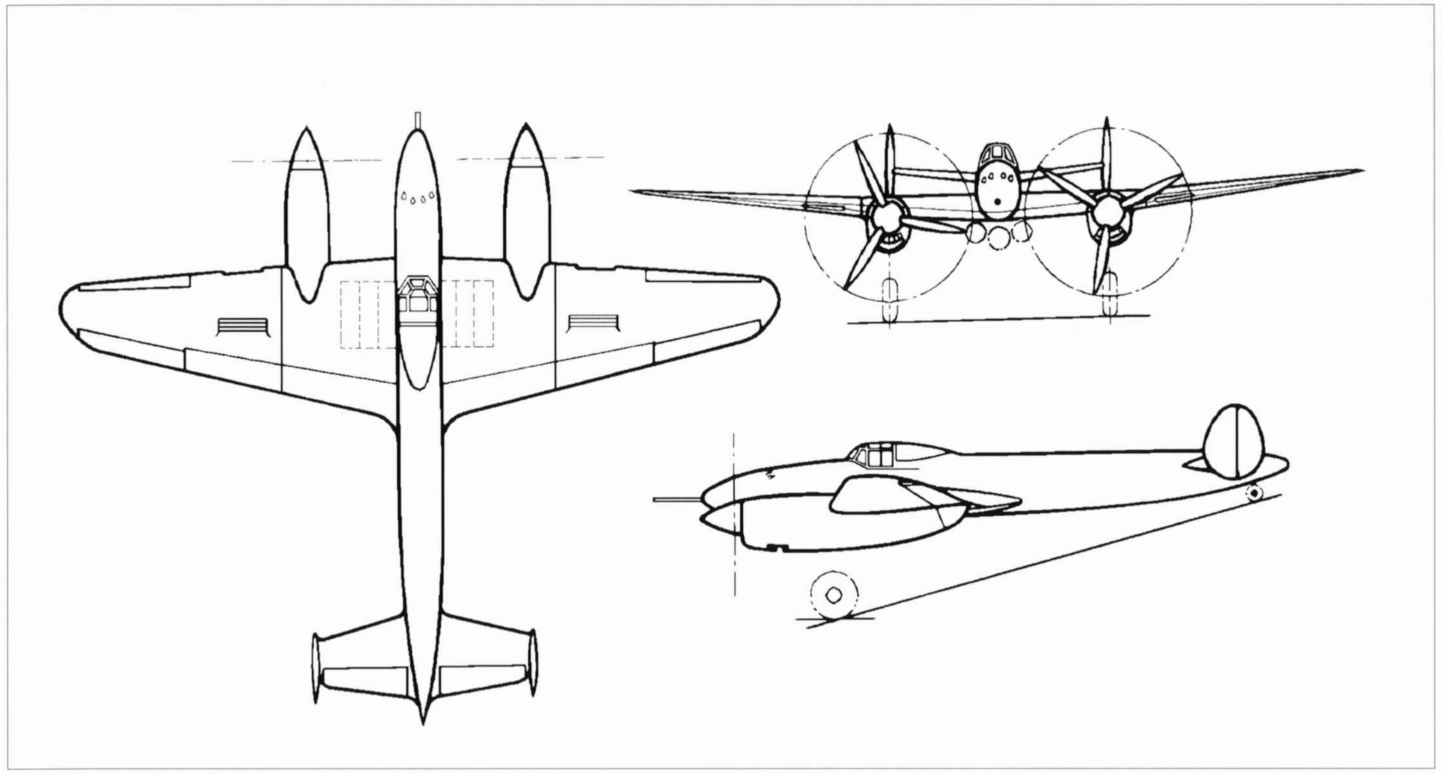


Ilyushin Aviation Complex



Top and above: This sleek wind tunnel model represents the TsKB-60 twin-engined attack aircraft (the first one to bear the IL-6 designation). Note the leading-edge slats.



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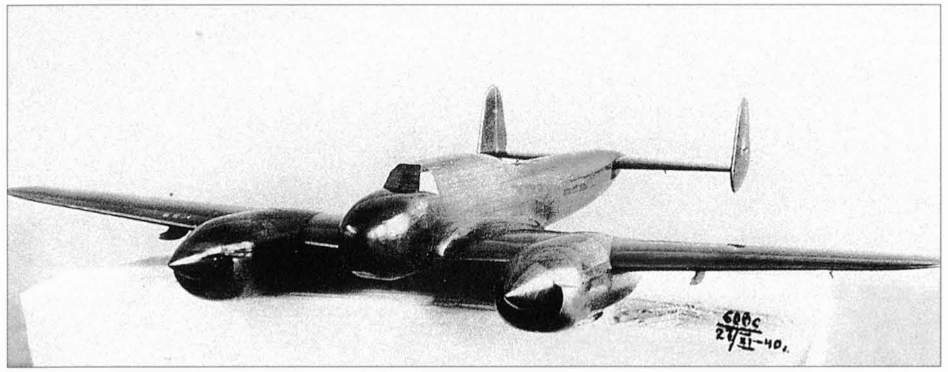
A three-view of the TsKB-60, showing the protruding 37-mm cannon and the quartet of smaller weapons buried in the nose, the three external stores stations under the wing centre section and the airbrakes on the outer wing panels.

TsKB-60 (IL-6) project

Several months before the outbreak of the war the Ilyushin Design Bureau began development of a heavy armoured attack aircraft with a greater bomb load and longer range than the IL-2. Designated TsKB-60, the original project envisaged an all-metal low-wing twin-tailed monoplane powered by two AM-38 engines. It was planned to produce it in two versions, a single-seater and a two-seater with defensive armament. The aircraft was to have heavy offensive armament. One of the proposed armament fits comprised a 37-mm nose cannon, two 23-mm cannon and four 12.7-mm or 7.62-mm machine-guns. The aircraft would be able to carry internally a normal bomb load of 600 kg (1,320 lb), its maximum bomb load reaching 1,000 kg (2,205 lb).

The preliminary design was approved on the eve of the war, by which time the aircraft had been redesignated IL-6. A mock-up was completed in the spring of 1941. When the war broke out, however, the OKB and the aircraft factories were too busy increasing output and eliminating the defects of the production IL-2, and the project was shelved (the IL-6 designation was later re-used for a twin-engined bomber powered by diesel engines; see Chapter 2).

It is not quite clear whether Ilyushin was referring to the IL-6 (TsKB-60) or to some new, but similar project in his report dated 16th February 1943 on the activities of his OKB (Plant No.240) in 1942 in which he stated that in the second quarter of the year the OKB had started (or resumed? – the authors' note) design work on a single-seat armoured attack aircraft powered by two AM-38s. This design work, he wrote, had lasted from 20th April to 16th September 1942. *'At the stage when the degree of technical completion had reached 75% for the design work, 80% for the mock-up construction and 100% for wind tunnel model construction* – Ilyushin wrote – *the work was halted because the design team had switched to a new subject – a single-engined attack aircraft powered by an AM-42 engine.'*



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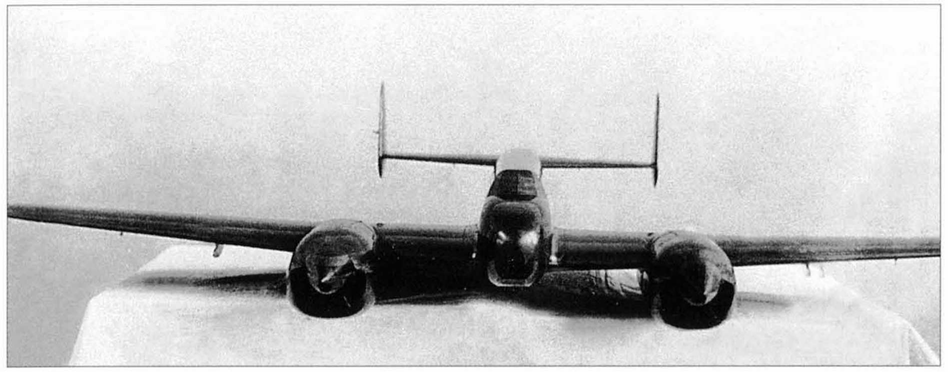

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Top and above: Another wind tunnel model, this time showing the two-seat version designated TsKB-60-2. Note the different shape of the engine nacelles with wider water radiator/oil cooler intakes.

Piston-engined Attack Aircraft with Enhanced Visibility

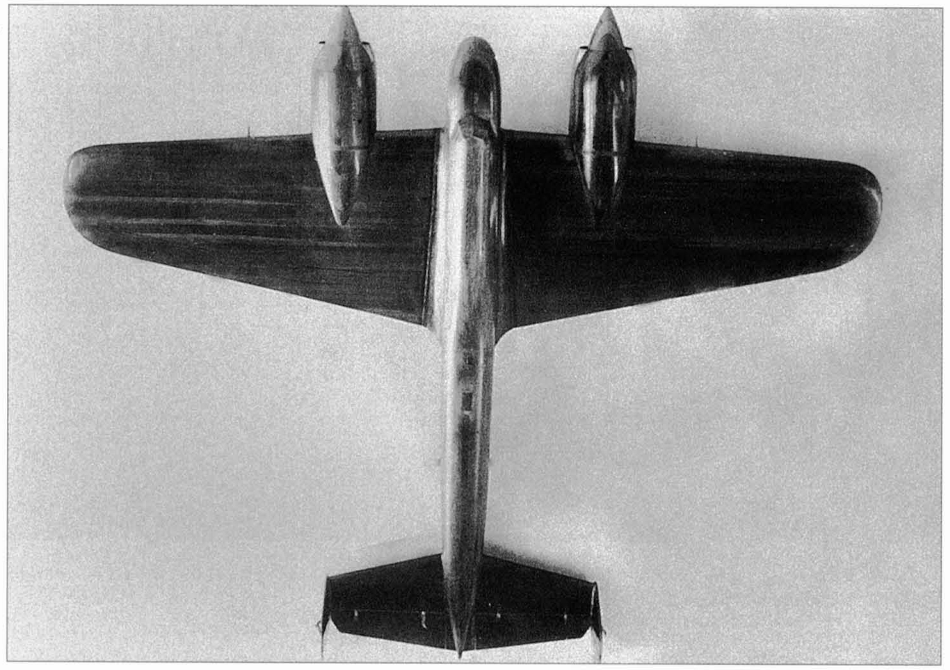
Combat experience during the war with Germany clearly demonstrated a serious drawback that was inherent in all single-engined attack aircraft and tactical bombers. It was the very restricted downward field of view for the pilot in the front hemisphere which made precise aiming very difficult, especially during level flight bombing. Various aiming devices designed to tackle the problem proved of little effect. Ilyushin came to the conclusion that the solution could be found in radically altering the layout of the aircraft. This approach found its expression in two projects developed by the Ilyushin OKB, one of which was brought to the prototype construction stage.

MSh attack aircraft (project)

In the spring of 1942 the Ilyushin OKB developed a project of a single-seat attack aircraft powered by a single AM-38 engine which was designated MSh. Advanced design project of this aircraft was sent by Ilyushin to Red Army Air Force Chief Engineer A. K. Repin on 22nd July 1942. The aircraft had some features in common with the Bell P-39 Airacobra fighter. To obtain a good field of view the engine was located amidships in the fuselage with the pilot placed ahead of the engine and thus enjoying an considerably improved view forward. The engine transmitted its torque to the propeller through an extension shaft passing under the floor of the cockpit. Also accommodated under the cockpit was the weapons bay which housed a 37-mm Shpital'nyy ShFK-37 cannon (some sources quote the weapon as the Nudelman/Suranov NS-37). Its barrel passed through the reduction gearbox and the hollow propeller hub. The NS-37 was supplemented by two synchronised ShVAK cannon and two synchronised ShKAS machine-guns. A normal bomb load of 400 kg (880 lb) could be carried in wing centre-section bomb bays.

The coolant and oil radiators were accommodated in the fuselage-enclosed part of the wing centre section; the external air was supplied to them via curved air ducts with air intakes in the wing leading edges at the sides of the fuselage (a feature later used on the IL-10). Oil and fuel tanks were placed between the cockpit and the engine.

The wings featured 15° leading-edge sweep dictated by the need to achieve a proper CG range. Unlike the P-39, the MSh featured a tailwheel undercarriage. In one of the project versions the main gear units retracted rearwards into the wings, the wheel turning through 90° to lie flat in the wings. The aircraft was heavily armoured; the armour shell protected the cockpit, fuel



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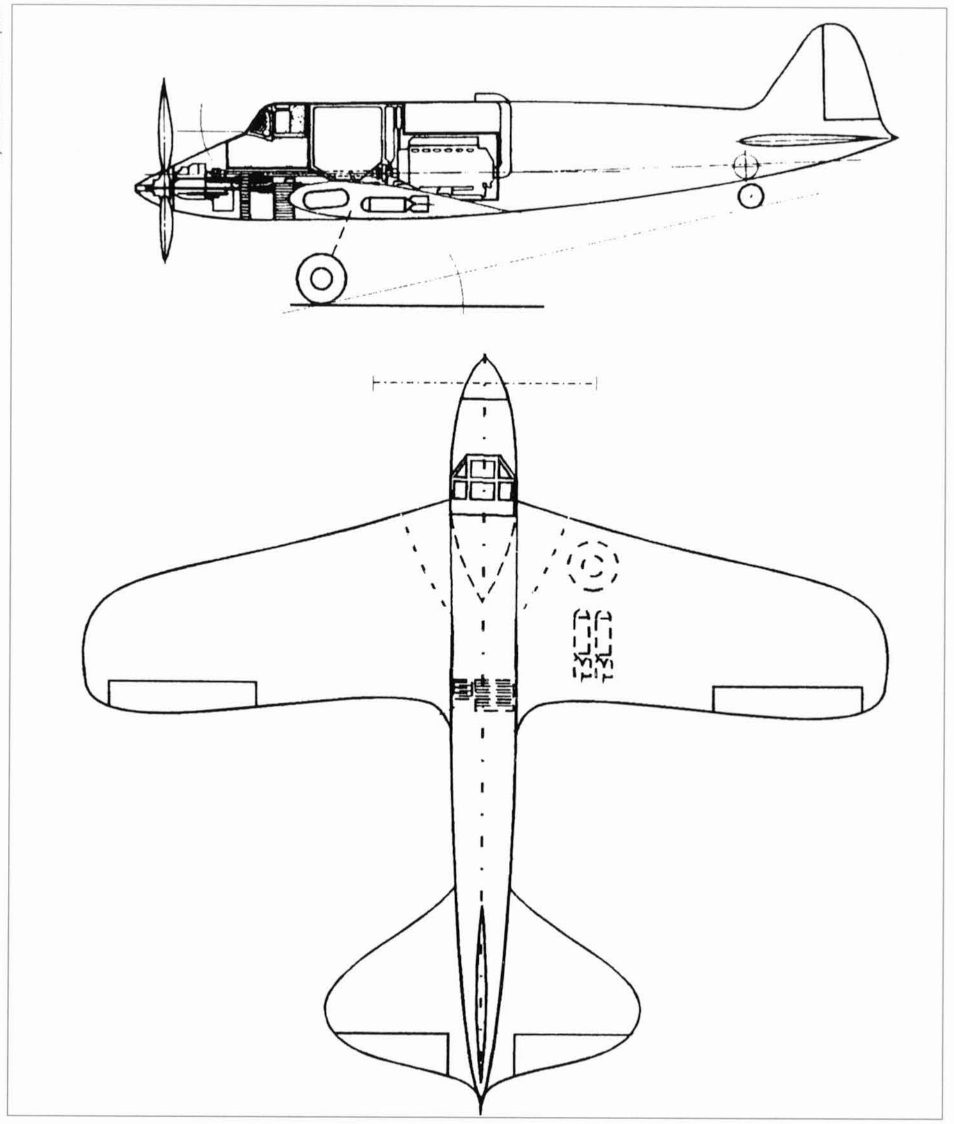
Above: A plan view of the TsKB-60-2 wind tunnel model. Note how much shorter the nose ahead of the windshield is as compared to the single-seater.



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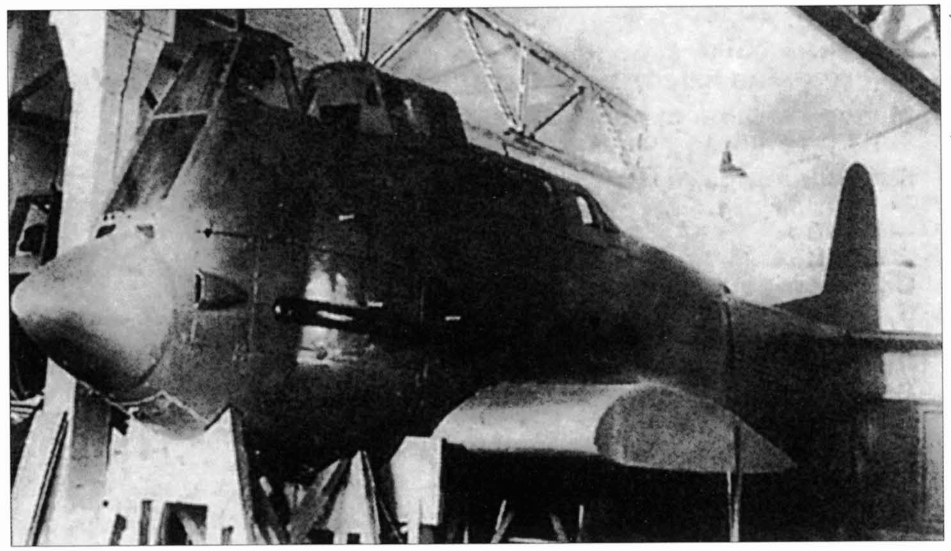
A diagram of the MSh attack aircraft, showing the buried engine with extension drive shaft and the inner wing bomb bays. Unlike some project configurations, the main gear units are inward-retracting.



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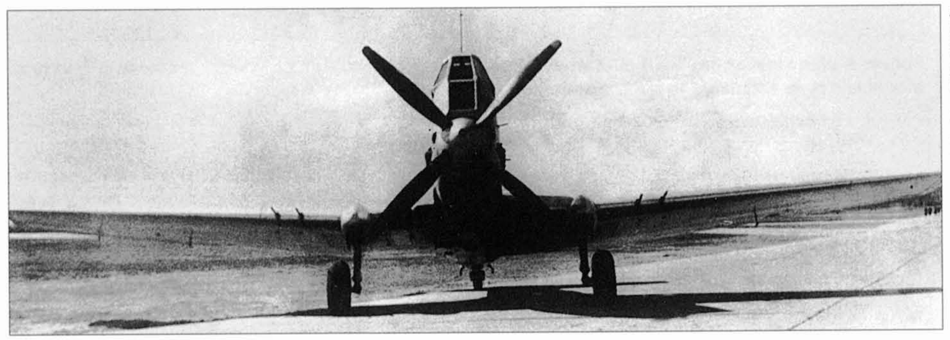
Above: A full-scale mock-up of the IL-20, showing the position of the cockpits above the engine and the extensive bulletproof glazing.



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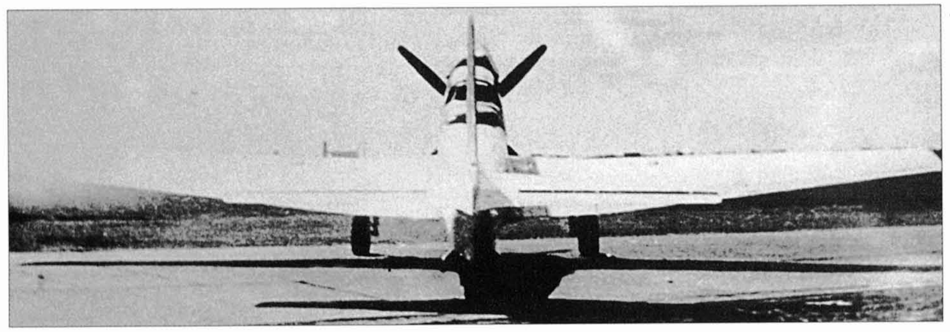
Above: Front view of the IL-20 prototype. Note the large propeller diameter.



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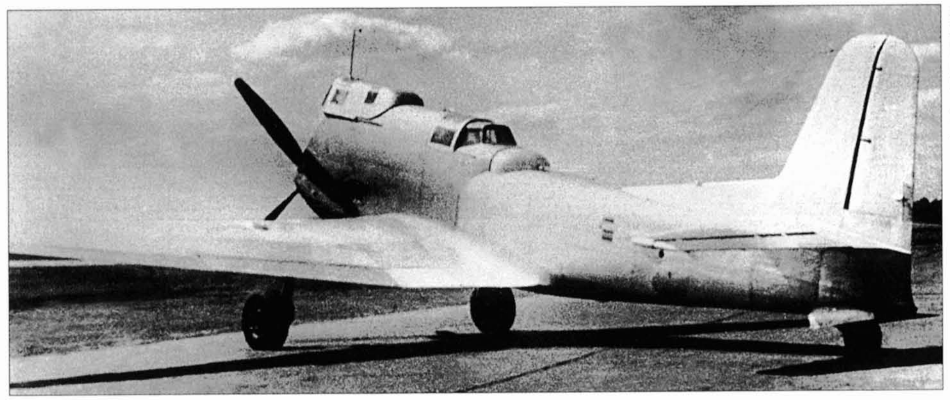
Above: Rear view of the IL-20 prototype.



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This three-quarters rear view of the IL-20 illustrates the stepped arrangement of the two cockpits and the IL-VU-11 powered dorsal turret. This arrangement gave the gunner an almost unrestricted field of view. The aircraft was totally devoid of markings.

tank, engine, oil and coolant radiators. To simplify production methods, armour plating consisted largely of single-curvature plates; this entailed an increase in the aircraft's empty weight and a deterioration in the design performance. Moreover, the adopted layout was at odds with the task of the day which emerged at that time – to provide attack aircraft with a gunner for protection against enemy fighter attacks from the rear hemisphere. It proved impossible to incorporate this feature in the MSh. Into the bargain, as evidenced by experience with the Bell P-39 and P-63 Kingcobra, the chosen layout was imbued with such inherent drawbacks as poor spin recovery and a propensity of the extension shaft to failing due to torsional vibrations. As a result, the design was abandoned.

IL-20 attack aircraft prototype

Ilyushin returned to his idea of building an attack aircraft 'endowed with good vision', as he put it, several years later, after the end of the war. A Government directive dated 11th March 1947 tasked the Ilyushin OKB with the development of an attack aircraft that would be superior to the IL-10 in performance and fire power. Pursuant to this directive, Ilyushin prepared an advanced development project of a heavy armoured attack aircraft designated IL-20. It was a single-engined low-wing monoplane of all-metal construction with a conventional tail unit and a retractable tailwheel landing gear. This aircraft employed a very unusual fuselage layout that had never been used before in world aircraft design. Its main distinctive feature consisted of placing the pilot's cockpit above the engine. Coupled with the very large windshield extending right down to the propeller hub, this afforded the pilot an exceptionally good view forwards and downwards. The pilot had a 37° downward angle of vision in horizontal flight; in a 40-45° dive he could see a target directly under the aircraft.

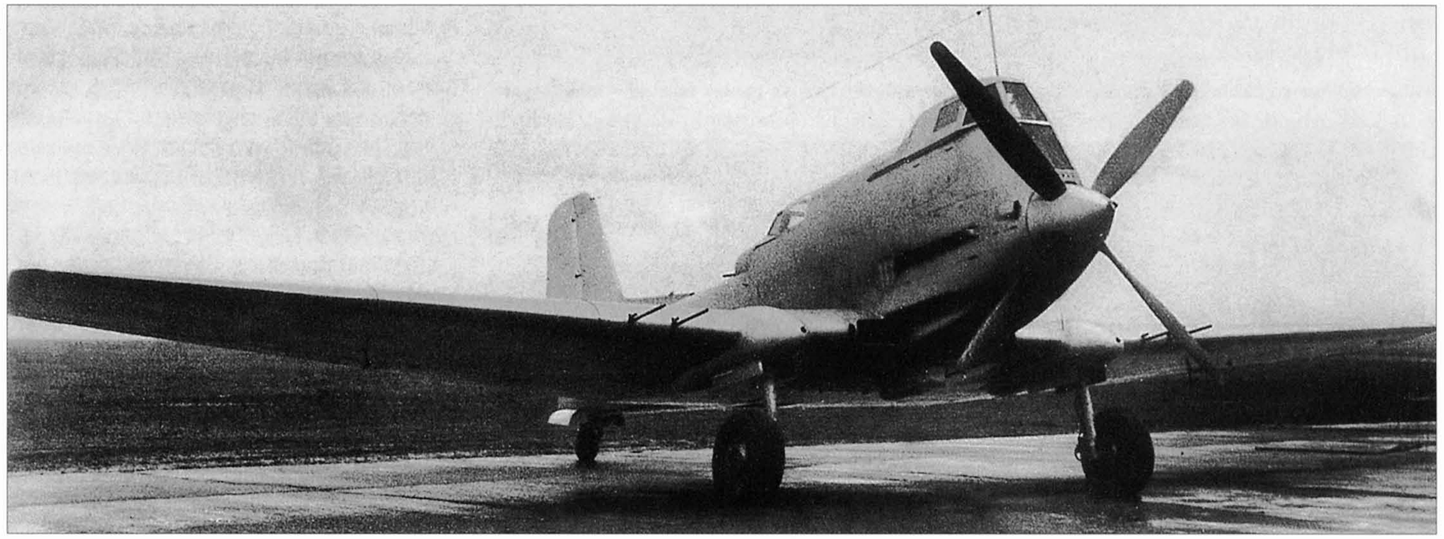
The aircraft was powered by an M-47 liquid-cooled engine (also known as MF-47) designed by M. R. Flisskiy (Aleksandr Mikulin's deputy at the Kazan' engine plant) and rated at 3,000 hp for take-off. (Early project versions, according to documents, were to be powered by the identically rated MF-45Sh engine. The designation M-47 appeared for the first time in the protocol of the mock-up review commission in July 1948; apparently the MF-45Sh was simply renamed M-47. The alternative designation M-45Sh can also be found in documents.)

The aircraft possessed a complement of both defensive and offensive armament which was unusual in many respects. Various armament arrangements were studied. The first version of the advanced development project, to be powered by the MF-45Sh, envisaged an aircraft fitted with a dorsal turret and downward-firing fuselage-mounted cannon. There were several variations of this armament fit. Common for all of them was the provision of the IL-VU-11 remotely controlled dorsal turret installed amidships (it is described below).

The first option of the offensive armament included two 23-mm wing-mounted cannon, to be fired in a dive or a shallow glide, and two 23-mm cannon obliquely mounted in the fuselage (at an angle of 23° to flight line), to be used for strafing large area targets in a level flight. Normal bomb load was 400 kg (880 lb), increased to 700 kg (1,540 lb) in overload configuration. In the latter case four launch rails for 132-mm rockets could be carried. The second offensive armament option envisaged the use of one 45-mm (1.77 calibre) cannon, two 23-mm cannon and six rocket projectiles. Some sources mention a projected installation of four obliquely-mounted cannon in the fuselage (an available drawing depicts the aircraft featuring four such cannon in a tandem arrangement of two pairs in the lower part of the centre fuselage). These cannon were allegedly supplemented by as many as four similar weapons mounted in the wings, although this sounds incredible.

One more armament arrangement was under consideration at the development stage of the project. Also powered by the M-45Sh, this version featured a tail turret of the IL-K8 type for protection against attacks from the rear; in this turret the gunner was protected by bulletproof glass panels of a thickness ranging from 65 to 100 mm (2.56 to 3.94 in) and metal armour plates of thickness ranging from 4 to 10 mm (0.16 to 0.39 in). The offensive armament, as in the previous case, included obliquely mounted cannon in the lower fuselage. Judging by the available drawing, there were two such weapons, presumably supplemented by wing-mounted cannon. Placing the rear gunner in a tail turret necessitated lengthening the fuselage and relocating the wings which were moved a little aft for CG reasons. This version was abandoned in favour of the version with a dorsal turret.

The weapons fit with the dorsal turret and fuselage-mounted oblique cannon was at one time considered to be the main project version, but it was altered when the prototype configuration was finalised. The fuselage cannon were discarded as being of limited use due to aiming difficulties; their deletion made it possible to increase the ammunition load for the four wing-mounted cannon to a sizeable 900 rounds. In addition, the cannon were deflectable.



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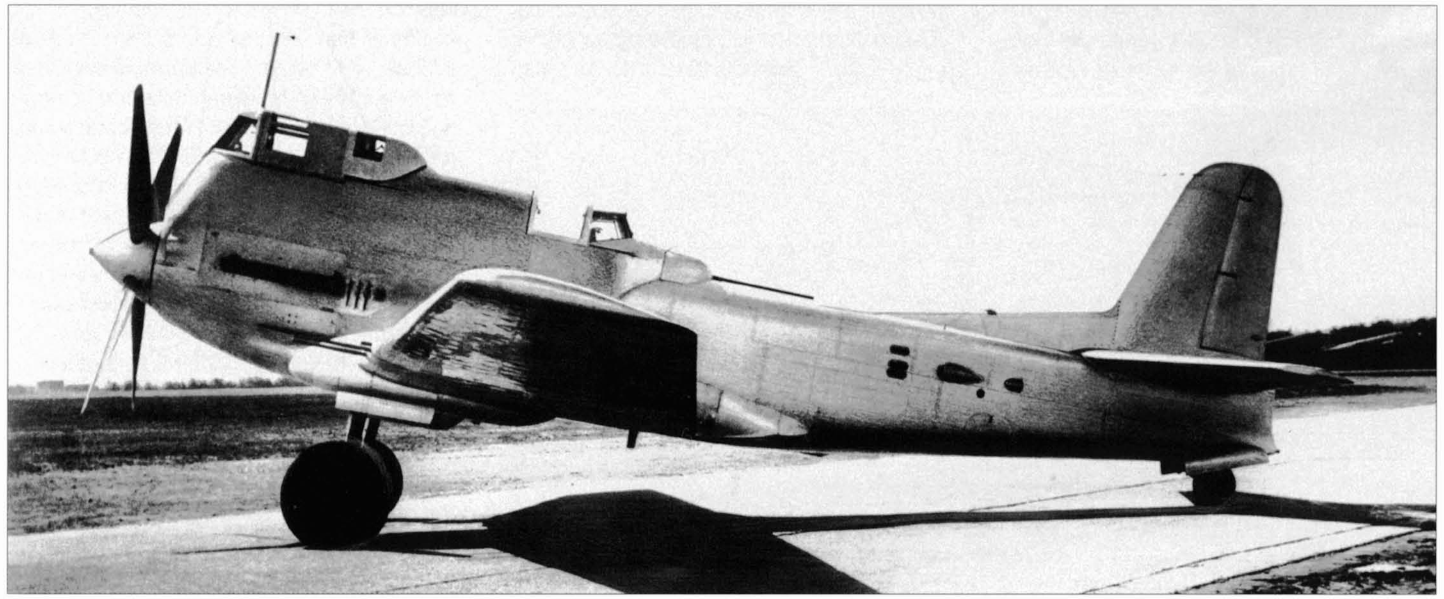
Above: A three-quarters front view of the IL-20 prototype. The wide-track IL-10 style main landing gear is clearly visible, as are the wing cannon.



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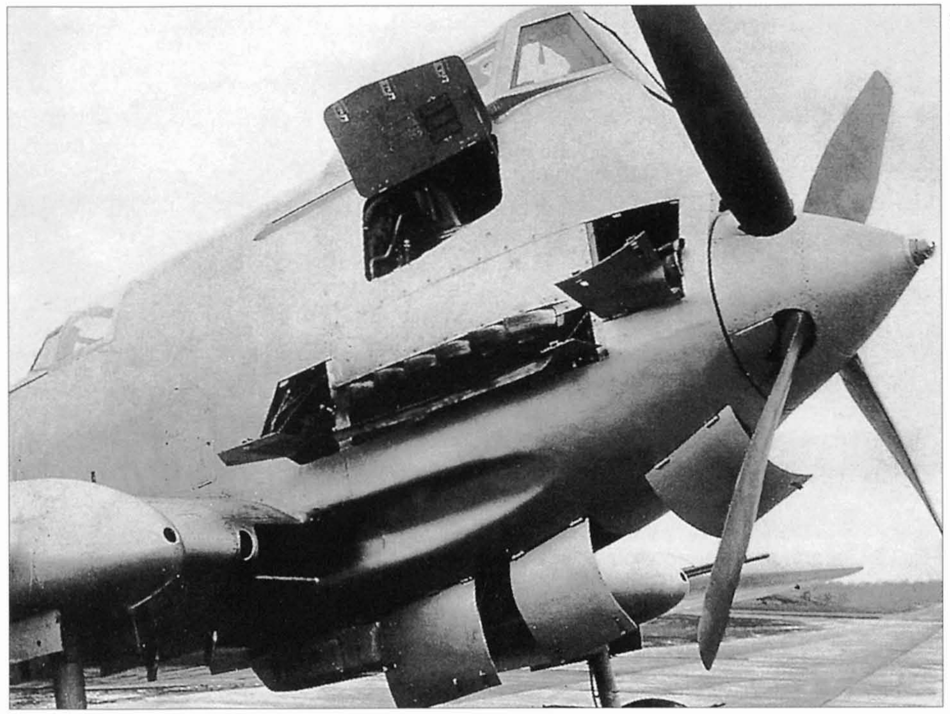
A side view of the IL-20 with the gunner's cockpit canopy open. It is easy to see why the IL-20 was code-named *Brawny* by NATO.



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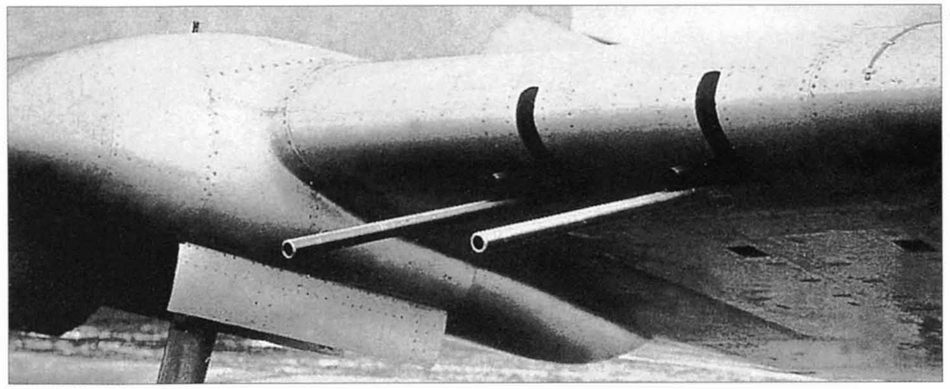
Above: Close-up of the IL-20's forward fuselage with the M-47's access panels opened for inspection.



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Above: Close-up of the IL-20's Sh-3 movable wing cannon at 23° maximum depression.

Specifications of the IL-20 prototype

Wing span, m (ft)	15.43 (50 ft 7½ in)
Length, m (ft)	13.58 (44 ft 6⅝ in)
Wing area, m² (sq ft)	44.0 (473.66)
Engine type	M-47
Max take-off power, hp	3,000
Nominal power at sea level, hp	2,300
Nominal power at rated altitude, hp	2,400
All-up weight, kg (lb)	9,500 (20,950)
Maximum speed, km/h (mph):	
at sea level	450 (280)
at 2,800 m (9,190 ft)	515 (320)
Maximum range, km (miles)	1,700 (1,057)*
Take-off run, m (ft)	500 (1,640)

* A figure of 1,180 km (733 miles) is quoted in some sources.

In its final version incorporated in the prototype the armament comprised the following elements. The rear gunner's cockpit was placed aft of the pilots cockpit and separated from it by the fuel tank; the gunner fired a 23-mm Shpital'nyy Sh-3 cannon through hydraulically actuated remote control. The cannon was installed in the IL-VU-11 turret (VU – ***verkh**nyaya [strel**kov**aya] oost-**a**novka*, dorsal turret) which could be traversed through 90° to either side and elevated through 80°.The barbette was completely separated from the gunner's station which was provided with good armour protection including both metal armour and bulletproof glass. Defence against attack from the downward part of the rear hemisphere was catered for by the provision of ten AR-2 aircraft grenades.

The offensive armament of the IL-20 prototype included four 23-mm Sh-3 cannon installed in the wings on adjustable gun mounts. They could be installed either horizontally (parallel with the direction of flight) or with a downward deflection of 23°. The latter configuration was intended for use against such targets as enemy troop columns or vehicle convoys which could be strafed by attack aircraft in level flight. The bombing armament of the IL-20 included a maximum bomb load of 1,190 kg (2,624 lb) – a higher load compared to the initial design figures quoted above. Smaller bombs could be accommodated in four bomb bays in the wing centre section. Two 500-kg (1,102-lb) bombs could be carried on external bomb racks under the wings. Finally, there were guide rails for four RS-132 rocket projectiles.

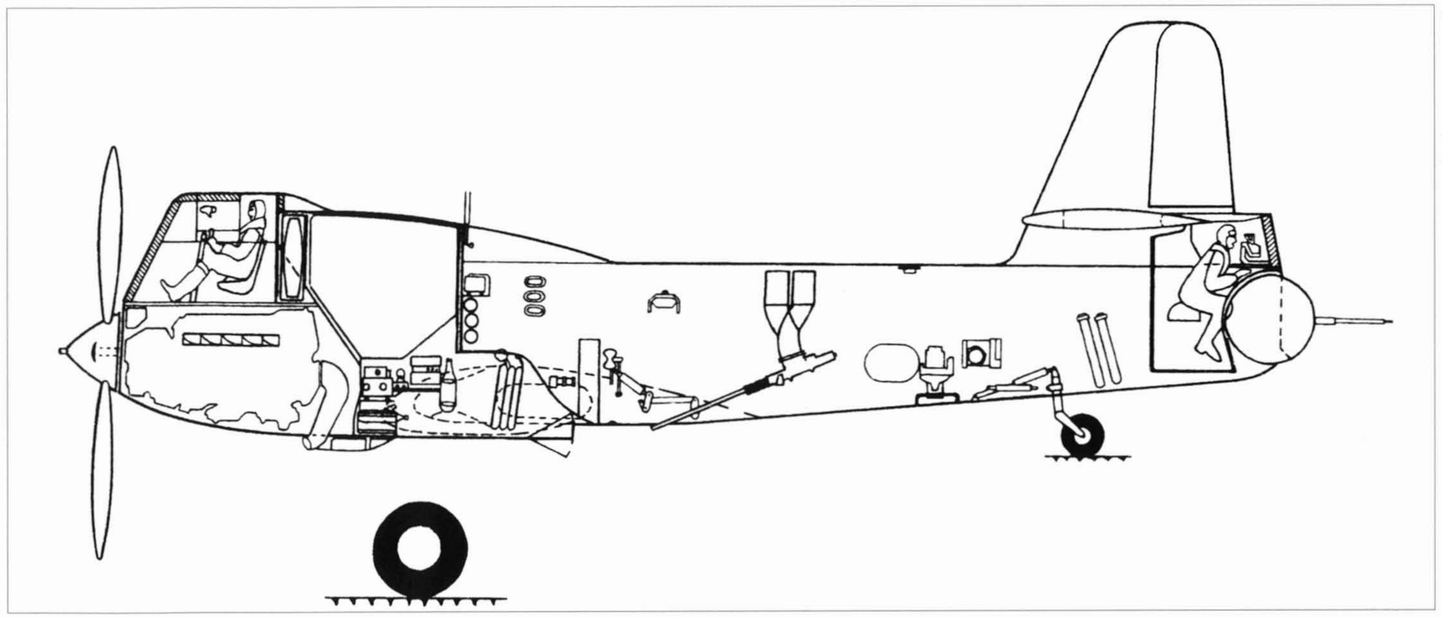
Armour protection was ensured by an armour shell which enclosed the pilot's and the gunner's cockpits, the engine, fuel and lubrication systems and cooling system. The thickness of armour plating varied from 6 to 15 mm (0.236-0.59 in). The weight of steel armour totalled 1,840 kg (4,060 lb). The pilot's cockpit had a bulletproof windshield of 100 mm (3.94 in) thickness; the windshield quarterlights were also made of bulletproof glass, 65 mm (2.56 in) thick.

Construction of the IL-20 prototype was completed by 27th November 1948. Early in December it made its maiden flight with test pilot V. K. Kokkinaki at the controls. During manufacturer's trials the aircraft attained a maximum speed of 515 km/h (320 mph) at 2,800 m (9,190 ft). This could hardly be regarded as an achievement – a production IL-10 attained 551 km/h (342 mph) at the same altitude. Obviously, this was the consequence of inherent drawbacks of the chosen layout. Placing the pilot above the engine entailed a greater cross-section and side area of the fuselage, resulting in increased drag and a weight penalty.

Insufficient performance was not the only flaw of the new aircraft. Just as important were troubles caused by serious defects of the 'immature' M-47 engine which manifested themselves in strong vibration during flight. These defects prevented the IL-20 from being submitted for State acceptance trials. There were also some other points of criticism. The military were not quite satisfied with the armament. With the cockpit above the engine, access to the latter was severely hampered, which made maintenance a tricky affair, to say the least. The close proximity of the propeller to the cockpit was believed to create a risk for the pilot in the event of bailing out or during a belly landing when the bent propeller blades might strike the cockpit.

All this prevented the IL-20 from reaching production status. In accordance with a Council of Ministers directive issued on 14th May 1949 all the work on the IL-20 was terminated. A contributing factor to this decision may have been the view prevailing at that time that the general transition to turbojet-powered aircraft dictated a need for a higher-performance attack aircraft (a view contested many years later by some researchers in whose opinion the IL-20 could have proved a useful addition to the Soviet Army's arsenal).

It remains to be noted that in addition to the IL-20 versions with the pilot's cockpit above the engine, Ilyushin studied two more versions which featured a layout similar to that of the IL-10. Better aerodynamics promised an improvement in performance over the unorthodox layout – at the sacrifice of the 'better vision'.



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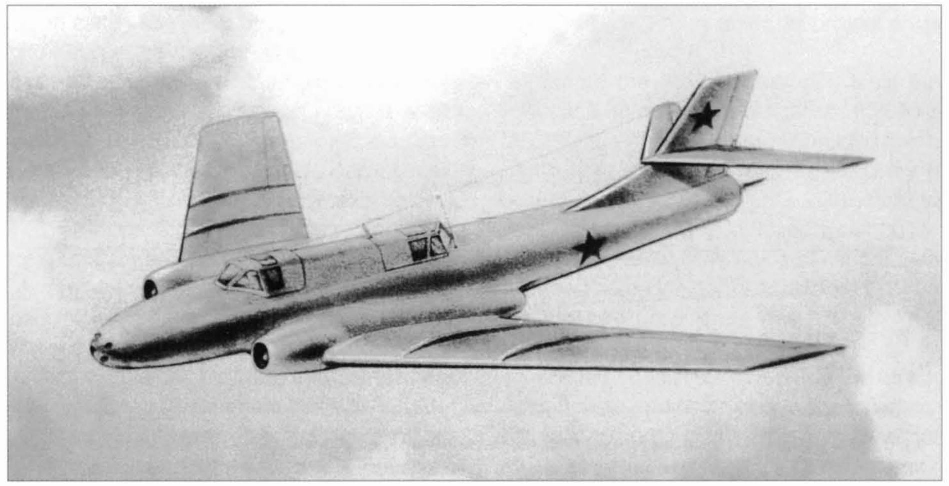
This early cutaway drawing of the IL-20 from the project documents shows a different arrangement with a gunner's station (featuring an IL-K8 turret), two obliquely mounted cannon inside the fuselage and a fuel tank aft of the cockpit.



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Above: An artist's impression of the IL-40 from the project documents. Note the very short nose housing a battery of six NR-23 cannon.

IL-40 armoured attack aircraft

In 1949 the IL-20 armoured attack aircraft completed its manufacturer's flight tests. Further efforts of the Ilyushin OKB staff were devoted to developing and putting into operation the IL-28 tactical bomber. Yet, the work aimed at developing and perfecting dedicated attack aircraft went on.

The world military aviation's transition to jet propulsion and the experience gained in the Korean War inevitably led to the emergence of a Soviet attack aircraft possessing higher performance characteristics than those obtainable with piston engines.

Design studies undertaken in 1950-51 at Ilyushin's initiative and under his direct guidance showed that such an aircraft could be built around a pair of Mikulin AM-5 axial-flow turbojets which had small dimensions, good fuel efficiency, low weight and a reasonably high thrust rating (they were also intended to power the Mikoyan/Gurevich MiG-19 tactical fighter and the Yakovlev Yak-25 loitering interceptor).

In late 1951 the OKB prepared a technical proposal (preliminary design study) for a two-seat armoured attack aircraft designated IL-40. The technical documents were prepared with the active participation of S. N. Chernikov, V. M. Ghermanov, N. P. Stolbovoy, V. M. Sheinin and other specialists. This proposal was sent to the government in January 1952 and was given prompt consideration; as early as 1st February the

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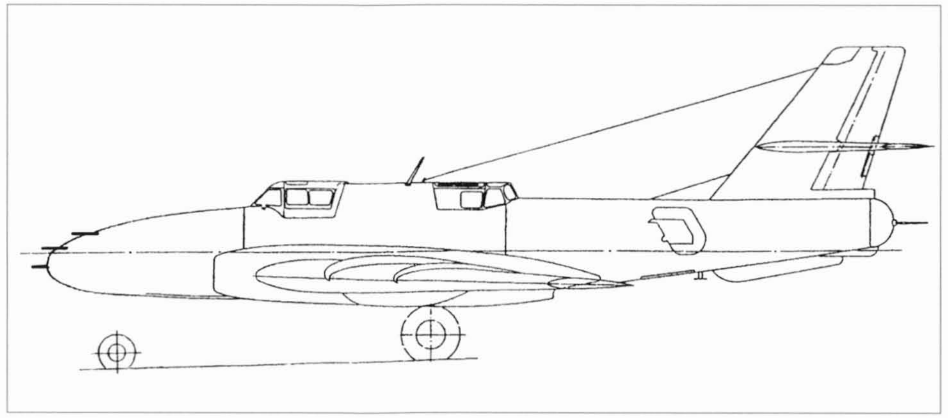
The first prototype IL-40 during a late stage of the flight tests. The longer, more pointed post-modification nose housing four TKB-495A cannon is readily apparent. Note the unguided rocket pods under the wings.



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A side view of the IL-40 from the project documents, showing the large airbrakes on the rear fuselage sides. Note the ventral strake and the much smaller dorsal fin as compared to the drawing on the preceding page.

Council of Ministers issued a directive which entrusted the OKB with designing the IL-40 and building a prototype.

IL-40 – the first prototype

The IL-40 was a twin-engined aircraft with low-set swept wings and a retractable tricycle undercarriage. The aircraft had a crew of two: a pilot and a gunner/radio operator. The main structural component was the armour shell (armoured body) which absorbed the loads from the engines attached to it, from the forward and rear fuselage sections and the wings. It housed unpressurised crew cockpits, six fuselage fuel tanks and part of the electrical and radio equipment. The armour shell was manufactured from steel plates of varying thickness; in addition, the pilot was protected from the front by an armoured bulkhead and a bulletproof windshield. Protection from above and from behind was afforded by an armour plate on the aft-sliding cockpit canopy and an armoured headrest. The gunner's cockpit also featured substantial armour plating. The weight of the aircraft's steel armour plating and of the bulletproof glass, together with fittings, totalled 1,918 kg (4,230 lb).

The fuselage structure, armour shell, cockpit canopy and ejection seats were designed by Valeriy A. Borog, Yu. V. Komm, Ye. A. Shushpanov, M. K. Tsymbalyuk, A. A. Beglov, A. S. Artamonov, Ghenrikh V. Novozhilov, I. Ya. Katyrev, A. A. Shakhnovich, S. I. Dmitriyev. The IL-40's powerplant was developed under the guidance of G. M. Litvinovich. A team led by Ye. I. Sankov designed the wings and the high-lift devices. N. I. Maximov was in charge of the tail unit design. The nose cannon installation and the tail cannon barbette were developed by a team headed by V. A. Fedulov. The technical documents for the tail barbette's remote control system were issued by A. P. Zhuravlenko. The bomb armament was developed under the supervision of D. I. Koklin. The engineers V. I. Smirnov, A. V. Shaposhnikov, M. I. Nikitin and B. Ya. Kapliyenko were responsible for the aircraft's special equipment. Manufacturing drawings and other documents for the aircraft's control system, undercarriage, hydraulic and pneumatic systems were prepared in the teams headed by V. N. Semyonov and A. Ya. Levin.

The work on the IL-40 attack aircraft proceeded at a very high tempo. This was due both to Ilyushin's outstanding organising abilities and to the great experience and high skill acquired by the design staff. As early as three and a half months after the Government had issued its directive, the VVS mock-up review commission headed by Air Major-General A. D. Reino, a wartime attack aircraft pilot, inspected the IL-40 mock-up and gave it a favourable assessment.

Construction of the IL-40 prototype was completed in February 1953. After a short period during which the systems and equipment were checked up and adjusted, on 7th March OKB test pilot Vladimir K. Kokkinaki took the IL-40 into the air. Engineer A. P. Vinogradov, who occupied the gunner's seat during test flights, shared the conduct of the test programme with him. A. I. Zhukovskiy was appointed project engineer for the manufacturer's tests of the IL-40.

During the first test flights the aircraft's performance and its stability and handling characteristics were assessed; all these were deemed satisfactory by the pilot.

At the end of March 1953 Kokkinaki flew to the Faustovo weapon test range with the intention of testing the nose cannon installation by firing it against a ground target.

The experienced pilot approached the test range at an altitude of 5,000 m (16,400 ft), put the aircraft into a shallow dive, pressed the buttons of the cannon – and then, all at once, he could no longer see the target, being dazzled by the gun blast. At the same time the engines spontaneously dropped their rpm abruptly, and then flamed out. Kokkinaki held his fire; he managed to restart the engines (fortunately, he had enough altitude for that) and made it back to base safely. Ilyushin was immediately informed about the occurrence. He gave orders to his staff to develop, as a matter of urgency, a research programme designed to study the unstable engine running during the firing of the IL-40's nose-mounted canon. Subsequently manufacturing drawing were issued for the installation of two types of muzzle brakes on the gun barrels and of eight types of blast suppressors of various kinds that were intended to deflect the blast gases to the sides of the air intakes.

Tests under this programme commenced on 1st April 1953. M. G. Ovchinnikov, an experienced weapons specialist, was appointed project engineer. Ground test firing with the engines running (accompanied by filming of the processes taking place at the cannon muzzles by high-speed cameras), as well as firing conducted in flight, showed that the use of muzzle brakes and blast suppressors gave no positive result: the engine ran down even when just one cannon fired a burst of five to ten rounds. Research in this direction was stopped. In addition, the tests revealed that, apart from the blast gases, the unstable engine operation was caused by pressure and temperature fluctuations in the flow entering the air intakes.

A decision was taken to replace the six nose-mounted NR-23 cannon with four more potent TKB-495A cannon developed under N. M. Afanas'yev and N. F. Makarov at the Tula Design Bureau (***Tool****'skoye kon-****strook****torskoye byu****ro***, hence the TKB). While having the same calibre (23 mm), the TKB-495A had a 50% higher rate of fire amounting to 1,300 rpm and weighed a mere 4 kg (8,82 lb) more than the NR-23. The TKB-495A cannon was subsequently included into the Soviet Air Force inventory under the designation AM-23. On the IL-40 every cannon had an ammunition supply of 225 rounds. The firepower of four TKB-495As was equal to that of six NR-23s. The aircraft's tail barbette was also fitted with a TKB-495A cannon.

A special cannon-blast deflector chamber was designed for the nose-mounted TKB-495A cannon; it formed a part of the attack aircraft's forward fuselage. The chamber was intended to deflect the gun gases that were produced during firing and let them escape into the outer air flow. It was manufactured as a detachable section made from heat-resistant steel and isolated from the fuselage; the lower part of the chamber was provided with a hatch with two doors. Their opening mechanism was interconnected with the cannon firing buttons. During the firing of the cannon the blast gases were expected to escape from the chamber into the air flow without getting ingested into the engine air intakes.

The TKB-495A cannon and the gas deflector chamber were installed on the first prototype. Problems cropped up immediately. When the nose-mounted cannon were fired, the blast gases accumulated in the gas deflector chamber section used for spent shell cases and links, and then ignited there. In some cases this caused a deformation of the gas deflection chamber. A remedy was found quickly: a thorough ventilation of the spent shell case section was introduced; coupled with the use of muzzle brakes, this ensured stable engine running during the operation of the nose-mounted cannon.

During test flights long bursts were fired in a four-cannon salvo without affecting the normal operation of the engines. The manufacturer's flight test report said:

'The latest design of the nose-mounted cannon installation featuring a gas deflector chamber has ensured reliable firing and functioning of the engines regardless of the altitude and flight speed, engine running mode and duration of a burst. In addition, the dazzling of the pilot when the weapons are fired has been eliminated.

When firing the cannon at different dive angles, both with and without the use of airbrakes, the aircraft displayed normal behaviour without any peculiarities.

Aiming is performed easily and confidently, the aircraft's movement in a dive is stable. The gunsight is convenient to use…

When 320 rounds are fired continuously from the nose-mounted cannon, the smell of gunpowder gases in the pilot's cockpit is insignificant.

(signed) Project test pilot, Air Major-General V. K. Kokkinaki. 19th December 1953.'

The results of the manufacturer's tests were immediately reported to Minister of Aircraft Industry Pyotr V. Dementyev. Being well aware of the interest taken in this question by the top leadership of the country, Dementyev sent a report to the Presidium of the Council of Ministers of the USSR, addressed personally to Gheorgiy M. Malenkov. He mentioned, among other things, the difficulties encountered during the testing which had prevented the IL-40 from being submitted for State acceptance trials in July 1953, as stipulated.

The reaction was prompt. As early as 31st December 1953 Marshal of the Soviet Union A. M. Vasilevskiy, deputy Minister of Defence, issued an order appointing a special commission for conducting the State acceptance trials. It was headed by Air Major-General M. G. Sklyarov, Hero of the Soviet Union, who had commander of a Guards Attack Air Regiment during the war.

In early 1954 the prototype construction plant cured the IL-40 of all the deficiencies that had been revealed during the manufacturer's tests; a new set of engines was installed. On 21st January the aircraft was transferred to GK NII VVS (State Red Banner Research Institute of the Air Force).

The State acceptance trials did not last long and were completed as early as 15th March. Major V. S. Kipelkin was project test pilot; other pilots flying the aircraft were Heroes of the Soviet Union Colonels Yuriy A. Antipov, Ivan M. Dzyuba, V. A. Ivanov and V. G. Ivanov. Lieutenant Senior Grade A. A. Yablonskiy performed the duties of the leading gunner/radio operator; A. S. Rozanov and S. G. Frolov acted as project engineers.

During the State acceptance trials the IL-40, at a normal all-up weight of 16,200 kg (35,720 lb) with a full ammunition load and a bomb load of 400 kg (880 lb), attained a maximum speed of 910 km/h (566 mph) at sea level and 950 km/h (590 mph) at 1,000 m (3,280 ft). The tactical radius of action at an overload all-up weight of 17,275 kg (38,090 lb) and with drop tanks was 270 km (168 miles).

Military specialists noted that the attack aircraft was endowed with easy handling. Flying personnel well acquainted with the MiG-17 and IL-28 jet aircraft would encounter

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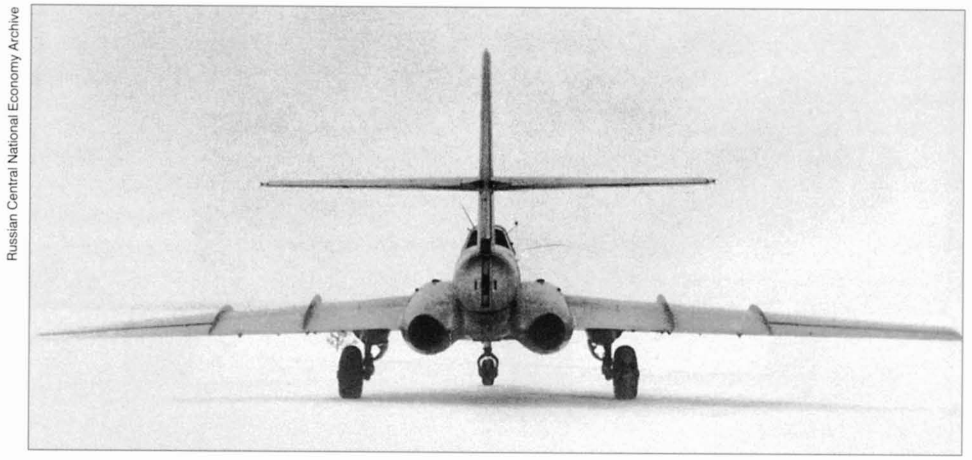

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Top, centre and above: The IL-40 during State acceptance trials. The elongated and unpainted extreme nose is a gun blast deflector chamber made of heat-resistant steel. Note the four wing fences.

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Above: The IL-40 was totally devoid of markings. The lateral apertures on the fuselage nose serve for ventilation of the gun blast deflector chamber to prevent the gases from accumulating and igniting inside. The mainwheels retracted forwards, turning through 90° to lie flat in the wings; note the mudguard on the nosewheel.

no special difficulties in converting to the IL-40 and flying it both in daytime and at night and in adverse weather conditions. The aircraft's behaviour at high indicated airspeeds and Mach numbers (up to the critical M=0.89) had no negative peculiarities. The IL-40 could perform limited aerobatics. When the aircraft approached high angles of attack, a warning buffeting occurred, as on swept-wing fighters. The installation of two engines did not entail piloting complications; at the same time it enhanced flight safety.

Also, the special tactical features of the IL-40 became a matter for assessment in comparison with the IL-10M piston-engined attack aircraft which was in squadron service with the Air Force at the time. A comparative analysis showed that the IL-40 was considerably superior to the IL-10M as regards maximum speed, range of speeds, rate of climb, practical use altitudes, bomb load and firepower of the cannon installation. It was noted that the aircraft's tactical radius of action and equipment made it possible to use it without redeployment for direct support of ground troops in a zone measuring 250 km (155 miles) in depth. The IL-40 could also perform visual and photo reconnaissance missions catering for the needs of the Air Force and general troops command.

A mock aerial combat session between the IL-40 and the MiG-15*bis* and MiG-17 fighters was staged during the State acceptance trials. It was stated that conducting well-aimed cannon fire against the attack aircraft performing manoeuvres presented difficulties due to the IL-40's high horizontal and vertical speeds, their wide range and because of the aircraft being fitted with efficient airbrakes.

When performing attacks against ground targets, the IL-40 proved to exhibit more stable handling than the IL-10M. It possessed a greater weight of fire and greater firing accuracy. Simultaneous use of all four cannon did not affect the piloting of the aircraft, the recoil being relatively small. The aircraft was tested in bombing missions performed in a dive at angles ranging from 30° to 50°, as well as for bombing from a horizontal flight at an altitude of 300 m (980 ft) at a speed of 700 km/h (435 mph). The weapons carried by the IL-40 proved to have a devastating hitting power.

However, in the course of performing flights involving side-slip with a simultaneous conduct of salvo cannon fire from the nose-mounted weapons (during the manufacturer's tests they were fired while the aircraft was flying a straight course to the target) there were cases of engine flameout or significant loss of rpm with a simultaneous growth of the exhaust gas temperature in excess of the limits. This phenomenon affected the engine which was on the side opposite to the direction of the sideslip.

At an early stage the test pilots had taken note of the overly aft operational CG position of the aircraft which amounted to 36-38% MAC. Coupled with the rather small wheelbase, this caused the aircraft to swing longitudinally when taxying on the uneven surface of field airstrips and made taxying, taking off and landing more difficult.

On the whole military pilots highly appraised the IL-40's performance and tactical characteristics; they recommended that the machine be put into production and adopted for introduction into squadron service after curing the deficiencies that had been revealed.

On 22nd April 1954 Air Force Commander-in-Chief, Air Marshal Pavel F. Zhigarev endorsed the document (Act) on the results of the State acceptance trials. After that the first prototype of the IL-40 performed only occasional flights. In the summer of 1956 it was demonstrated to the US delegation which had arrived to take part in festivities on the occasion of the Aviation Day. The guests were approving of the aircraft – they admitted that no other country in the world had a machine of that kind.

The cases of the IL-40's engines flaming out when its nose-mounted cannon were fired led the designers to seek new solutions. Together with specialists from TsIAM and NII-2 (later renamed GosNII AS – *Gosoodarstvenny naoochno-issledovatel'skiy institoot aviatsionnykh sistem*, State Research Institute for Aircraft Systems) they studied the possibility of enhancing the stability of the gas flow through the engine, but it turned out that this could be achieved at the expense of the thrust rating. Another solution developed by the specialists consisted of reducing the amount of fuel fed into the engine during the time when the cannon were fired; in this case the results were positive. However, Ilyushin suggested a more radical approach which involved a basically different mutual position of engine air intakes and the cannon. This new position completely eliminated any influence of the firing on the engine running.

Construction of the second prototype, the IL-40P, was started as the OKB's 'private venture'; it was intended to check the effectiveness of the new layout. This work was officially endorsed on 16th October 1954, when the Council of Ministers issued a directive calling for the series manufacture of the IL-40 at aircraft plant No.168 in Rostov-on-Don. The same document contained a clause on the construction of the second prototype.

IL-40P – the second prototype and production aircraft

Externally the IL-40P was markedly different from the first prototype. The main modifications were applied to the forward fuselage up to the first armoured bulkhead of the armour shell. The separate lateral air intakes of the engines were extended forwards and the bullet-shaped nose gave place to a twin nose air intakes (looking uncannily like a double-barrelled shotgun) with diverging air ducts. The nose-mounted cannon installation was transferred to the fuselage underside behind the nosewheel well where all four TKB-495A cannon were installed on a special mount.

To protect the cannon barrels from debris thrown up by the nosewheel, special shields were mounted ahead of the barrels; they were mechanically linked with the nose gear unit, extending simultaneously with it.

It was envisaged that the attachment of the cannon mount to the fuselage would be hinged; this would allow the whole cannon installation to be deflected downwards to an angle of 25°, allowing the pilot to increase the duration of cannon fire against ground targets of considerable length. On the prototype, however, the cannon mount was rigidly attached to the fuselage.

In response to wishes from the military the normal bomb load of the IL-40P was increased to 1,000 kg (2,205 lb); in overload

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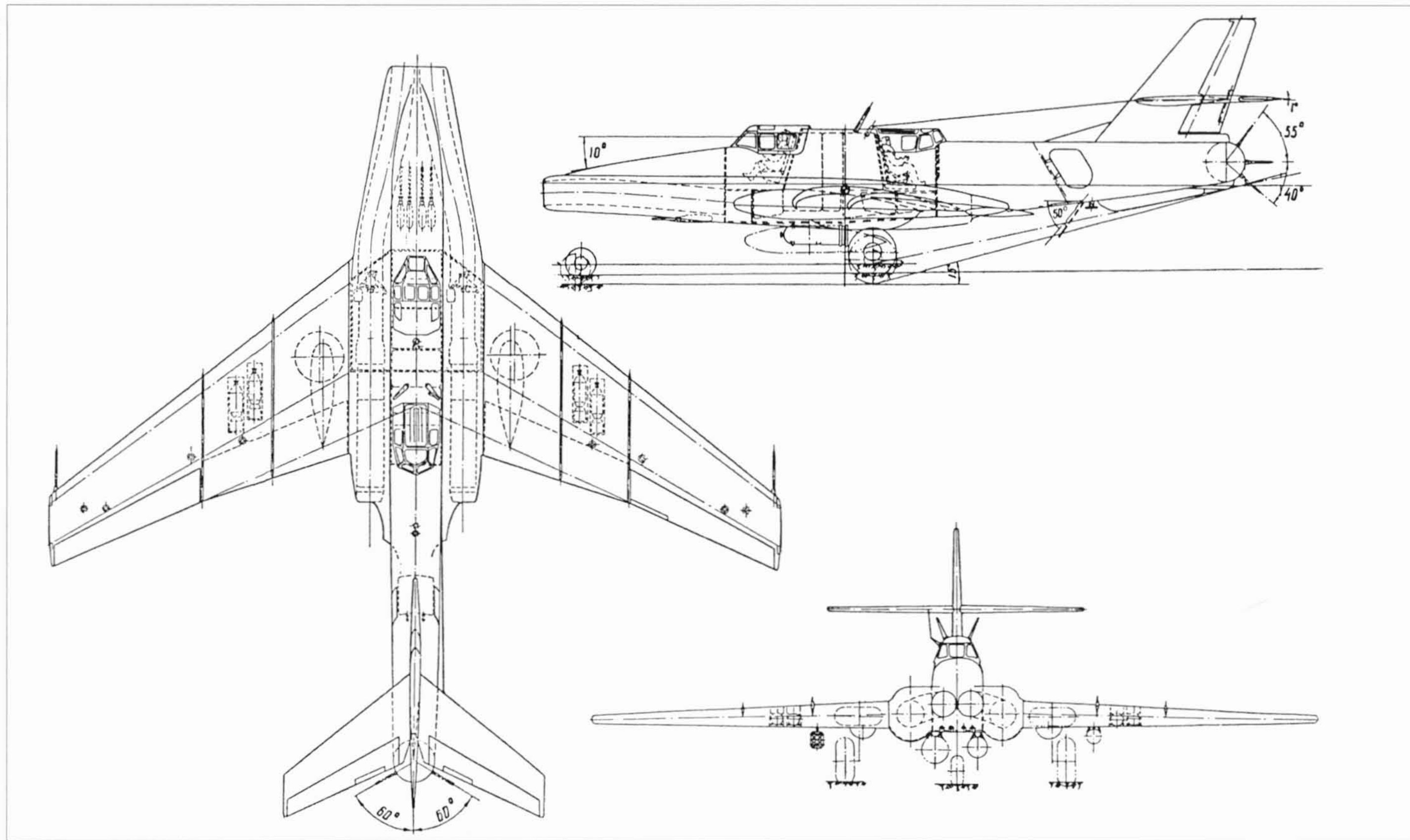
'The Peerless Shotgun'. The second prototype (designated IL-40P) featured a significantly redesigned forward fuselage, the inlet ducts being extended all the way forward to prevent gun blast gas ingestion. Note the relocated nose gear unit (hence the longer wheelbase) and Soviet Air Force markings.



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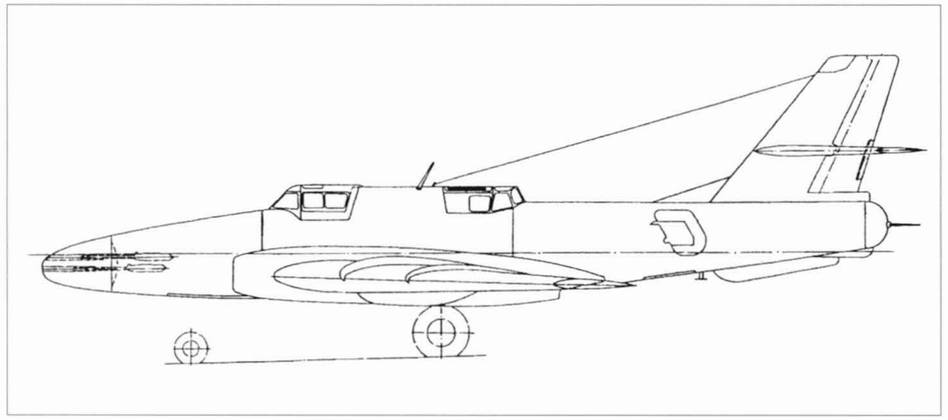
A three-view drawing of the IL-40P, showing the weapons placement (including the wing bomb bays and the tail barbette's field of fire) and the routing of the engines' inlet ducts.



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Above: Here, for comparison, is the original prototype IL-40 showing the weapons arrangement.

configuration it could carry a 1,400-kg (3,090-b) bomb load. The second prototype was powered by more powerful RD-9V engines with a take-off rating of 2,600 kgp (5,733 lb); with the afterburner turned on they had a take-off rating of 3,250 kgp (7,166 lbst). The rest of the IL-40P's airframe was identical to that of the first prototype.

The second prototype (IL-40P) was completed in early 1955; on 14th February it flew for the first time with Vladimir K. Kokkinaki at the controls. Yakov A. Kutepov was engineer in charge of the testing. Thorough trials of the weapons in all thinkable modes of combat use showed that the IL-40P could fire its cannon in a salvo and launch TRS-21-2 rocket projectiles with the aircraft in any attitude and the engines in any mode of operation, at all speeds and altitudes, without affecting powerplant operation. Moving the nosewheel strut forward and thus increasing the wheelbase had a positive effect on the aircraft's stability when taxying.

To meet a demand from the military who closely followed the progress of the IL-40P's manufacturer's tests, a mirror periscope was mounted on the sliding cockpit canopy, thus ensuring a good view of the rear upper hemisphere.

State acceptance trials commenced on 12th October 1955. The military pilots made certain that the main deficiency of the aircraft had been eliminated, and confirmed their previous conclusion that it was necessary to put the aircraft into production and introduce it into the Air Force inventory. As a result, an appropriate draft directive of the Government was prepared; it was visaed by Minister of Defence Gheorgiy K. Zhukov, Air Force Commander-in-Chief Pavel F. Zhigarev, Minister of Aircraft Industry Pyotr V. Dementyev and other high-ranking officials. The work on the IL-40 enjoyed support from Council of Ministers Chairman Nikolay A. Bulganin and his deputies V. A. Maltsev, Mikhail V. Khrunichev and S. I. Rudenko.

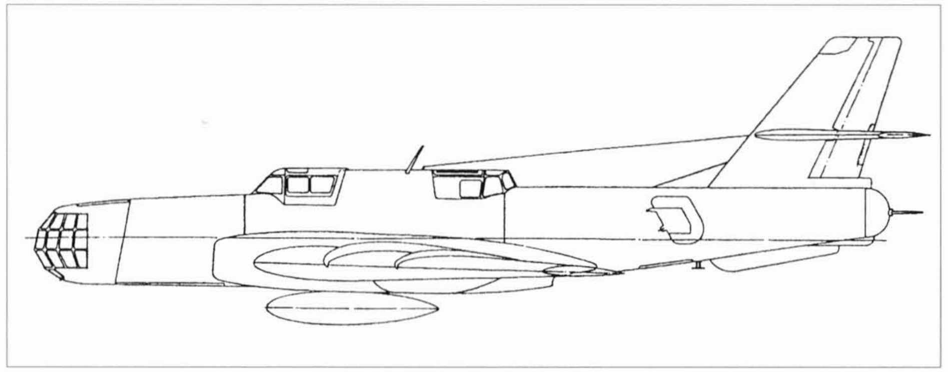
Concurrently the series production of the IL-40 was getting under way at Plant No.168. As is often the case in such situations, a considerable rearrangement of production facilities had to be put into effect; new production methods had to be devised and introduced. A production batch of forty machines was envisaged. The first five forward fuselages of the IL-40P, because of the changes introduced into their design, were manufactured at the OKB's prototype plant whose director at that time was Dmitriy Ye. Kofman. By the spring of 1956 five production examples of the IL-40P were rolled out to the apron of the flight-test facility of Plant No.168; they were undergoing development and check-ups on the ground.

At the height of this activity the Government issued its directive dated 13th April 1956, cancelling series production of the IL-40P and ordering all the work on this machine stopped 'in connection with the adoption of new types of weapons for the Soviet Army'. The entire stockpile of components for the first production batch of IL-40Ps was scrapped.

An order signed by the Soviet Minister of Defence on 20th April 1956 abolished the Attack Aviation arm of the Soviet Air Force. It was superseded by the Fighter-Bomber Aviation; the new military doctrine took into account the possibility of using tactical nuclear weapons and took a different view of the functions of the Air Force over the battlefield.

In the opinion of military specialists of that time, the main forces ought to be directed for delivering strikes against objectives located out of reach of ground troops. Thus, the availability of a dedicated attack aircraft (in this case, the IL-40) within the Air Force became superfluous. Not until two decades later, after a thorough analysis of the role of aviation in local conflicts did specialists again recognise the need for such aircraft providing direct support to troops on the battlefield.

When design work on the IL-40 was commenced it envisaged from the outset developing several versions on the basis of the initial model.



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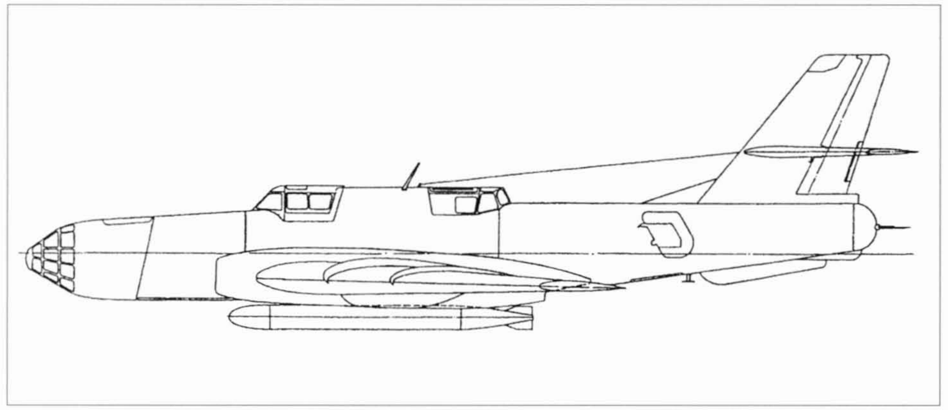
Above: A side view of the projected IL-40K artillery spotter aircraft. The extensively glazed navigator's station in the nose was designed to offer the maximum possible field of view and protection.



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A side view of the projected IL-40T torpedo-bomber. The nose is again glazed but has an altogether different shape, as high speed was an important requirement. Note the navigator's dorsal escape hatch.

IL-40K artillery spotter (project)

The IL-40K (*korrekti**rov**shchik*) was intended for use as an artillery spotter aircraft. It retained a high degree of commonality with the baseline model and differed from it only in having a new forward fuselage which was completely redesigned and featured a glazed cockpit for a third crew member – the spotter-navigator. His workstation was protected by armour, and bulletproof glass was used for the front, side and lower cockpit glazing. The RD-9V engines had lateral air intakes, as on the first prototype, and the cannon armament was to be placed in the wings in the space formerly occupied by wing bomb bays. The first prototype IL-40K was already under construction, the fuselage assembly nearing completion, when the directive killing off the IL-40 was issued.

IL-40T armoured torpedo-bomber (project)

The IL-40T was a project for a torpedo-bomber (T = *torpedo**nos**ets*) for torpedo attacks from high and low altitudes. As on the IL-40K, the navigator was accommodated in a glazed cockpit in the forward fuselage. This, however, was more streamlined; the upper and lower front glazing panels were optically flat and were used for sighting during torpedo attacks. The location of the engine intakes and cannon armament on this aircraft was identical to those of the IL-40K. Work on the IL-40T was discontinued at an early stage.

Structural description of the first prototype IL-40

The IL-40 was a twin-engined low-wing monoplane with swept wings and tail surfaces. The crew comprised two members – a pilot and a gunner/radio operator.

Fuselage: The *forward fuselage* was attached to the front armoured bulkhead of the armoured shell. Besides incorporating the nosewheel well, it housed six NR-23 cannon and some equipment items.

The *centre fuselage* was the main structural element of the airframe; it was an armour shell absorbing the loads from the engines, the forward and rear fuselage sections and the wings. It housed unpressurised tandem cockpits, fuel tanks and part of the electric and radio equipment. The armoured shell was manufactured from steel plates with a thickness varying from 3 to 8 mm/0.12-0.31 in (depending on the probability of the protected parts of the machine being hit by anti-aircraft or air-to-air fire). The pilot was protected from enemy fire by a 10-mm (0.39-in) armoured bulkhead installed in front of the cockpit and by a 124-mm (4⅞-in) bulletproof windshield. The windshield sidelights had a thickness of 68 mm (2⅝ in). Protection from above and from behind was assured by an armour plate 8 mm (0.31 in) thick on the sliding part of the canopy and by an armoured headrest 16 mm (0.63 in) thick. The gunner's cockpit also had a strong armour protection consisting of steel armour plating with a thickness of 4-10 mm (0.16-0.39 in).

The cockpit canopies had two independent emergency jettison systems: a pneumatic one (activated by the face blind firing handle of the ejection seat) and an electric one (activated by pressing a button on a cockpit console).

The *rear fuselage* which was attached to the rear armoured bulkhead of the armoured shell carried the vertical tail. In addition, the rear fuselage housed some of the aircraft's special equipment. Three large perforated airbrakes were located on the sides of the rear fuselage and beneath it; they could be opened to a maximum angle of 50°. The lateral airbrakes opened in a traditional way against the slipstream, while the lower airbrake was unusual in being aft-hinged, opening in the direction of the air flow. The airbrakes enhanced the aircraft's manoeuvrability over the battlefield, making it easier to attack ground targets in a dive.

Placed at the end of the rear fuselage section was the IL-K10 tail barbette.

Wings: Low-set cantilever wings of trapezoidal planform. Sweepback at quarter-chord 35°, total area 52,3 m² (563 sq ft). The wings made use of TsAGI airfoil sections: the SR-Yus-12 with a thickness/chord ratio of 18.44% at the root and SR-11-12 with a thickness/chord ratio of 12.86 at the tip.

The wings were a two-spar structure built in three pieces – the centre section permanently attached to the armour shell and two detachable outer wing panels. The wing centre section was provided with a deflectable landing flap, and the detachable wing panels carried TsAGI-type slotted flaps (modified Fowler flaps), with ailerons outboard of these.

Tail unit: Cantilever cruciform tail surfaces. The aircraft's stabiliser and fin had a two-spar structure; the control surfaces were mass-balanced and aerodynamically balanced and were provided with trim tabs.

Landing gear: Hydraulically retractable tricycle type, with single wheel on each unit; pneumatic extension in an emergency. The nose unit retracting aft into the forward fuselage had a wheel measuring 660 x 285 mm (25.98 x 11.22 in). The main units retracting forward into the wings were fitted with 1,100 x 400 mm (43.3 x 15.74 in) brake wheels. During retraction the wheels rotated 90° around the oleo struts to lie flat, face up, in the space between the wing spars. The nosewheel well was closed by twin lateral doors which remained open on the ground;. The mainwheel wells were closed by three doors each (twin forward doors and a small segment inboard of the main gear fulcrum), the oleo being enclosed by a narrow teardrop fairing on the wing underside. The larger doors opened only when the gear was in transit; this enhanced the reliability of the undercarriage when the aircraft was operated from dirt or snow-covered airstrips or soggy runways.

Powerplant: Two Mikulin AM-5F axial-flow afterburning turbojets with a take-off rating of 2,150 kgp (4,740 lbst) dry and 2,700 kgp (5,950 lbst) reheat. The engines were located on the sides of the armoured shell between the wing centre section spars, close to the aircraft's longitudinal axis; this location of the engines made the aircraft easier to handle in the the event of an engine failure. The air intakes protruded slightly beyond the wing leading edge, the air ducts passing through the front spar of the wing centre section; the engine jetpipes passed through the rear spar of the wing centre section. In these places the front and the rear spars were ring-shaped. On the outer side and from below the engines were protected by armour 4 mm (0.16 in) thick.

Control system: The rudder and elevators were actuated by a rigid linkage consisting of tubular rods; the linkage was duplicated all the way from the cockpit to the bellcranks in the rear fuselage. The linkage to the ailerons was of a mixed type and comprised cables in the armoured shell and tubular rods in the wings. The aileron and rudder control circuits included reversible hydraulic actuators placed within the armour shell.

Fuel system: The armoured shell accommodated six fuselage fuel tanks with a total capacity of 4,285 litres (942.7 Imp gal). Two auxiliary fuel tanks could be suspended under the fuselage.

Hydraulic system: The hydraulic system had a working pressure of 110 kg/cm² (3,000 psi) and was intended, among other things, for braking the wheels, controlling the automatic braking device, extending and retracting the airbrakes and closing the bomb bay doors.

Pneumatic system: The pneumatic system with a working pressure of 150 atmospheres was intended for the reloading of weapons and for replenishing the hydraulic accumulator. In addition, it served for the emergency braking of the wheels, for the emergency retraction of airbrakes and for opening the cockpit canopies. Survivability of the aircraft in combat was catered for by accommodating the piping of the hydraulic and the pneumatic systems on different sides of the fuselage.

Anti-icing system: Hot-air anti-icers were installed in the leading edges of the wings, the stabiliser and the fin and in the air-intake lips; the hot air was tapped from the engine compressors. The windshield of the pilot's cockpit was heated electrically.

Armament: Six 23-mm (.90 calibre) NR-23 cannon designed by A. E. Nudelman and A. A. Rikhter were originally mounted in the forward fuselage. The cannon had a rate of fire of 800 rpm and were installed in vertical rows of three on each side. The ends of their barrels protruded; the ammunition supply comprised 900 rounds (150 rpg)

Mounted in the extreme aft fuselage was the IL-K10 tail barbette which was remote-controlled from the gunner's cockpit. It was intended for protecting the aircraft from the attacks of enemy fighters and for engaging ground targets when the aircraft was leaving the scene after the strike. The barbette was fitted with one NR-23 cannon with an ammunition supply of 200 rounds. It was electro-hydraulically powered and incorporated a tracking system. The cannon had a maximum elevation of 55°, a maximum depression of 40° and a traversing angle of ±60°. Maximum cannon travel rates were 42° per second in the horizontal plane and 38° per second in the vertical plane.

The considerable thickness/chord ratio of the wings not only provided stowage for the main undercarriage units but also made it possible to provide four small bomb bays, each suitable for carrying bombs weighing up to 100 kg (220 lb). In addition, four bomb racks could be installed under the wing centre section and the outer wing panels. They could carry either two bombs weighing up to 500 kg (1,102 lb), or ORO-type launch rails for the TRS-132 or TRS-82 unguided rocket projectiles, or drop tanks with a total capacity of 1,100 litres (242 Imp gal) suspended on racks under the wing centre section.

The IL-40's normal bomb load, under the terms of the Government directive and the operational requirement issued by the military, was 400 kg (882 lb); in an overload configuration the aircraft could carry a bomb load of 1,000 kg (2,205 lb). Within this overload figure one could also install launch rails with eight TRS-132 or twelve TRS-82 rockets.

Avionics and equipment: The IL-40's equipment served to ensure the aircraft's operation and combat use of its weapons in day and night time, under simple and adverse weather conditions.

The piloting/navigation and radio communications equipment comprised an NI-50 navigation indicator, an AGI-1 artificial horizon, an RV-2 radio altimeter, an MRP-48P marker beacon receiver, an RSIU-3M command radio, an RSB-5 communications radio and an SPU-5 intercom. A Bariy IFF transponder was provided.

Specifications of the IL-40 aircraft

	IL-40	IL-40P	IL-40K
Powerplant	2 x AM-5F	2 x RD-9V	2 x RD-9V
Take-off rating, kgp (lbst):			
dry	2 x 2,150 (4,740)	2 x 2,600 (5,730)	2 x 2,600 (5,730)
reheat	2 x 2,700 (5,953)	2 x 3,250 (7,170)	2 x 3,250 (7,170)
Wing area, m² (sq ft)	52.3 (563)	54.1 (582,4)	54.1 (582,4)
Wing span	16.0 m (52 ft 6 in)	17.0 m (55 ft 9½ in)	17.0 m (55 ft 9½ in)
Length overall	17.215 m (56 ft 5¾ in)	17.215 m (56 ft 5¾ in)	16.911 m (55 ft 6 in)
Height	5.76 m (18 ft 10⅝ in)	5.76 m (18 ft 10⅝ in)	5.76 m (18 ft 10⅝ in)
Maximum take-off weight, kg (lb)	17,275 (38,090)	17,600 (38,810)	18,000 (39,690)
Normal take-off weight, kg (lb)	16,260 (35,850)	16,600 (36,600)	17,000 (37,485)
Maximum speed, km/h (mph):			
at 1,000 m (3,280 ft)	950 (590)	954 (593)	900 (559)
at 3,000 m (9,840 ft)	958 (595)	993 (617)	n.a.
Time to altitude, minutes:			
to 1,000 m	1.7	1.7	n.a.
to 3,000 m	3.8	2.6	n.a.
Maximum range with drop tanks, km (miles)	1,320 (820)	1,300 (808)	n.a.
Service ceiling, m (ft)	11,600 (38,060)	n.a.	n.a.
Take-off run at normal take-off weight, m (ft)	750 (2,460)	750 (2,460)	n.a.
Landing speed, km/h (mph)	195 (121)	201 (125)	n.a.
Armament:			
forward-firing cannon, 23 mm (0.90 calibre)	4	4	4
rearward-firing cannon, 23 mm	1	1	1
normal bomb load, kg (lb)	400 (882)	1,000 (2,205)	-
overload bomb complement, kg (lb)	1,000 (2,205)	1,400 (3,087)	-

For firing the cannon, launching the rockets and for bombing the pilot used a PBP-6 collimating sight which made it possible to conduct bombing in level flight at different altitudes, as well as in a dive. The sight effected automatically both the timing and the actual dropping of the bombs with the help of the ESBR-3P electric bomb release mechanism. The results of combat missions were recorded by NAFA (night) and AFA (day) still cameras installed in the rear fuselage. Aiming the tail barbette cannon was effected by means of an SPB-40 gunsight.

Emergency escape system: The cockpits were provided with ejection seats; the pilot was ejected upwards and rearwards at an angle of 16°, the gunner – upwards and forwards at an angle of 9°.

IL-42 armoured attack aircraft (project)

In 1967-68 the research workers of GosNII AS B. P. Toporov, G. K. Kolosov, G. A. Ryabchikov, O. S. Korotin and others spent much effort on evolving the general configuration of a prospective Soviet aircraft intended for direct support of ground forces. At that time the top command of the Soviet Air Force had concentrated its attention on the implementation of the concept of a fleet comprising exclusively supersonic fighter-bombers. Under these circumstances the idea of creating a subsonic attack aircraft was met with mistrust, and attempts to put it into practice encountered serious opposition from the customer (the Ministry of Defence). This opposition was so strong that the subsonic attack aircraft as a direction of effort would have been closed down without thinking and would not eventually have had a chance for development, had it not been for the resolute attitude of the leadership of GosNII AS personified by its director, Academician Yevgeniy Fedosov. He argued his case in contacts with the policy-making state bodies and received active support from General Designers Sergey V. Ilyushin and Pavel O. Sukhoi. Ilyushin supported the idea of a subsonic attack aircraft from the outset; somewhat later the Sukhoi OKB, too, joined actively in the work along these lines, having embarked at its own initiative on PD studies of a light subsonic attack aircraft.

On 25th April 1968, after an interruption of many years in the history of the Soviet Attack Aviation, the Commission on military-industrial matters (VPK – *Voyenno-promyshlennaya komissya*) – a standing committee of the Presidium of the Soviet Council of Ministers – adopted a decision stating the need for the development of a jet-powered attack aircraft. However, not until a year later, in early 1969, did the Soviet Minister of Defence Marshal Andrey A. Grechko address Minister of Aircraft Industry Pyotr V. Dement'yev with a request that the work be initiated on the development of an attack aircraft capable of meeting the new operational requirements. In March of that year Design Bureaux led by S. V. Ilyushin, P. O. Sukhoi, Artyom I. Mikoyan and Aleksandr S. Yakovlev conducted on a competitive basis the work aimed at evolving preliminary design studies of a light attack aircraft meeting the Air Force specifications.

The project of the IL-42 attack aircraft which was developed under the guidance of S. V. Ilyushin by members of the OKB's general layout team headed by V. M. Ghermanov retained the basic features of the IL-40 aircraft; However, it envisaged the use of up-to-date engines, new weapons, and more advanced flight and mission avionics (specifically, targeting systems). In retaining the two-seat layout and the tail barbette, the aircraft's designers proceeded from their analysis of the character of warfare in contemporary local conflicts and of the crew's work conditions. In their opinion, a serious threat was posed to an attack aircraft not only by enemy fighters and combat helicopters, but, most importantly, by the new weapon which had emerged by then: shoulder-launched surface-to-air missiles which, as a rule, hit the aircraft from the rear hemisphere. If protected by a gunner from the most dangerous direction, the pilot, as witnessed by the experience of the Second World War, felt more confident and could concentrate entirely on performing his main mission – that of seeking out and destroying targets on the battlefield.

The growing complexity of the weapons, equipment and systems of an attack aircraft, coupled with the emotional and physical stresses sustained by the pilot of a jet attack aircraft on a combat mission, also dictated the need to have an onboard gunner/operator who, in addition to his main mission of protecting the aircraft, could monitor the functioning of some onboard systems.

However, the military did not approve the concept of the IL-42's two-crew cockpit. They called into question the enhanced protection of the attack aircraft afforded by this layout and pointed out that it would entail an increase of the personnel of the tactical aviation within the Air Force and necessitate opening new schools for training the gunner/operators. In addition, they were of the opinion that an attack aircraft ought to have a maximum speed of no less that 1,000-1,200 km/h (621-746 mph).

On 9th July 1969 the IL-42's preliminary design study materials were sent for consideration to the appropriate research institutes of the Ministry of Defence and the Ministry of Aircraft Industry. In the same month all the attack aircraft projects submitted for the competition were studied. After a lengthy discussion on the maximum speed of an attack aircraft the customer rejected the projects of the two-seat aircraft: the IL-42 from the Ilyushin OKB and the Yak-LSh from the Yakovlev OKB (the latter was, in fact, a version of the Yak-28 light bomber with the cockpits protected by armour plating). The competition between the single-seat aircraft, the T-8 from the Sukhoi OKB (an armoured attack aircraft which eventually was declared the winner of the competition and put into series production as the Su-25) and the MiG-21LSh light attack aircraft from the Mikoyan OKB (which was expected to be based on the MiG-21PFM fighter well established in production) was extended to the stage of prototype construction.

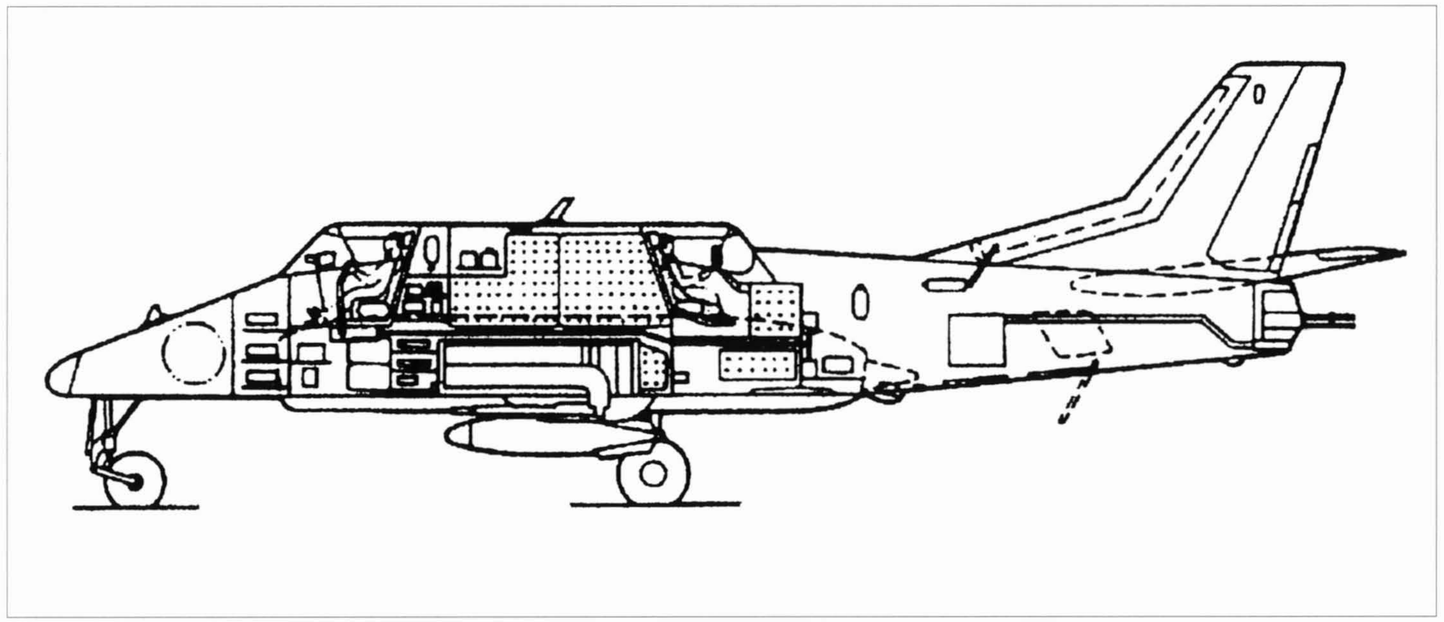
IL-102 (OES-1) close support aircraft

The work on evolving operational requirements for an attack aircraft went further on for quite some time; not until 1972 was the customer, at last, in a position to present their final version. In accordance with the new specifications issued by the VVS it was necessary to develop a subsonic attack aircraft possessing a maximum attainable survivability, high manoeuvrability, and an ability to be committed to action at the shortest possible notice when required by ground troops.

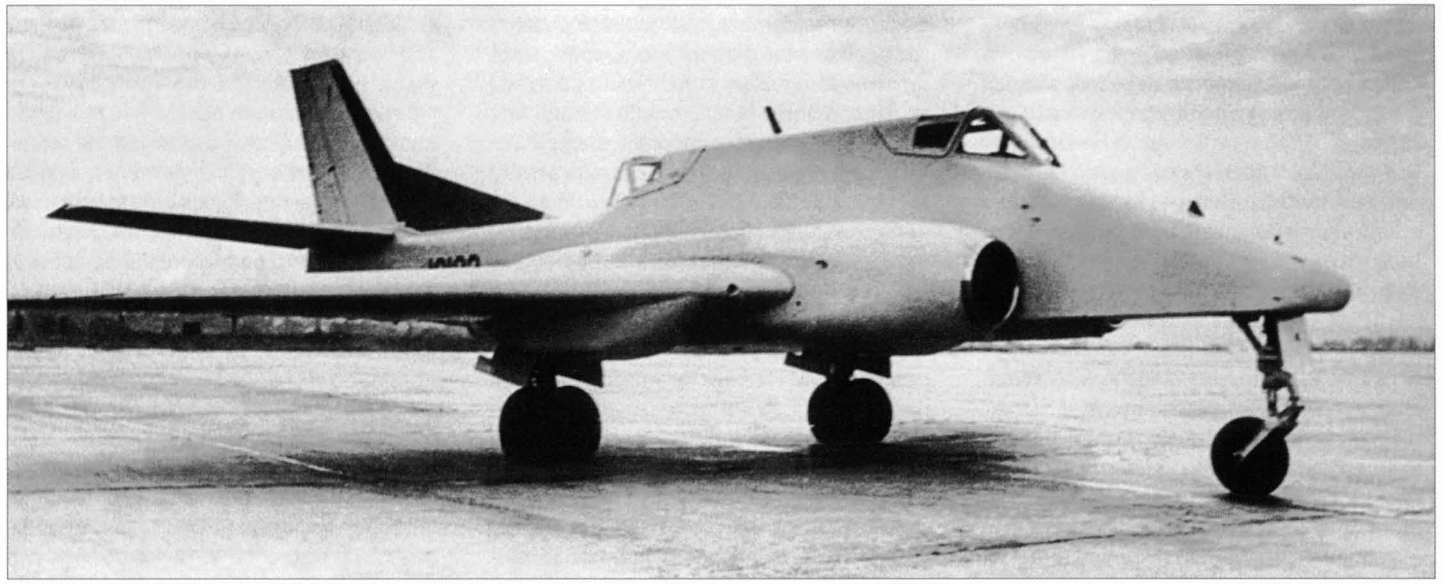
Although the IL-42 project had been rejected, the Ilyushin OKB, at its own initiative, continued working on the concept of a subsonic armoured attack aircraft intended for supporting ground troops on the battlefield. As a result, the IL-42 project was considerably reworked.

An analysis conducted with due regard to the peculiarities of combat aviation activities in the Arab-Israeli conflicts of those years showed that the two-seat IL-40 and IL-42 aircraft would represent the closest possible response to novel elements of the new military doctrine which gave up the use of mass destruction weapons on the battlefield and marked a transition to the use of precision-guided munitions. This was accompanied by a further increase of the pilot's workload, especially at low altitudes; in the opinion of the OKB's specialists, this workload was already in excess of what was humanly possible. This was corroborated also by the assessment of the combat efficiency of foreign single-seat attack aircraft which proved to be some 25% lower than expected. On the other hand, having a second crew member enabled the attack aircraft to spend more time attacking the

Ilyushin Aviation Complex



A cutaway diagram of the IL-102 attack aircraft, the modern edition of the IL-40. The space between the cockpits is occupied by fuel tanks filled withe explosion-suppression foam.



Ilyushin Aviation Complex

Above: The first prototype IL-102 during trials. While the general similarity to the first prototype IL-40 is plain to see, the slab-sided fuselage, the low-set dihedral stabilisers, the bulkier engine housings and the redesigned main landing gear are equally apparent. The aircraft was painted in light grey primer overall, except for the fin leading edge and fillet which were made of glassfibre and painted bright red. Note the registration 10102 on the rear fuselage.

target. The pilot sought out the target and attacked it on a head-on course, the gunner/operator continued to bring his gun to bear on the target while the aircraft was leaving the scene; at the same time he protected the aircraft from being hit by an artillery shell or rocket launched in pursuit of the aircraft. There was one more point to be taken into account: the progress of avionics could enable the gunner/operator, despite his aft-facing position, to conduct observation of the battlefield together with the pilot. Using information from his display, the gunner/operator could aim and launch rocket weapons against ground targets relieving the pilot from this operation and enabling him to concentrate on piloting, especially at extremely low altitudes, and on firing the guns. The participation of the gunner/operator in the attack made it possible to hit not one, but several targets during one pass, which served still further to enhance the attack aircraft's combat efficiency.

The new version of the project for a close support aircraft which was being developed as a 'private venture' under the guidance of Ghenrikh V. Novozhilov (who became General Designer of the OKB upon retirement of S. V. Ilyushin in 1970) received the designation IL-102. In comparison with the IL-42 it featured the following changes:

- cockpit visibility was improved;

- engines with thrust-vectoring nozzles were installed;

- the airframe incorporated a system of autonomous maintenance means which ensured the attack aircraft's high mobility in conditions of front-line deployment at short unprepared airstrips with a bearing strength of 5 kg/cm^2 (71 lb/sq in).

Ilyushin Aviation Complex

IL-102 '10102' comes in to land at Zhukovskiy after a test flight, apparently landing on the old runway which is no longer in use. Note the retired Tupolev Tu-95 bomber and Tu-144D airliner on LII's dump beyond.

In designing the IL-102, special attention was paid to precluding the possibility of a situation in which firing the onboard weapons would affect engine operation, the aircraft's structure and the view from the pilot's cockpit. The mutual location of the cannon installation, the air intakes and the cockpit, dictated by these considerations, determined the general layout.

The aircraft was configured as a twin-engined low-wing monoplane with thick swept wings and dihedral tailplanes mounted on top of the rear fuselage. The powerplant comprised two Klimov (Izotov) RD-33I turbofans (I stands for *izmeneniye vektora tyagi vniz* – downward thrust vectoring) with a take-off rating of 5,200 kg (11,466 lb) each. The RD-33I was a non-afterburning version of the production RD-33 engine developed by the Klimov OKB and manufactured in series for the MiG-29 fighter. The engines flanked the centre fuselage, breathing through individual air intakes which protruded slightly ahead of the wing leading edge. The nozzles could be deflected downwards both for take-off and in level flight, thus improving the aircraft's manoeuvrability and field performance considerably.

The thick swept wings developed for the IL-102 under the guidance of G. G. Muravyov jointly with TsAGI featured a new aerodynamic configuration. The wings enabled the aircraft to attain a speed of 950-1,000 km/h (559-621 mph) at sea level while keeping the minimum control speed down to a mere 250 km/h (155 mph). Such a wide range of speed characteristics enabled the crew to arrive quickly at the battle area in response to any request from ground forces. It could fly at an altitude of 30-100 m (100-330 ft) under conditions of ground fire, low visibility

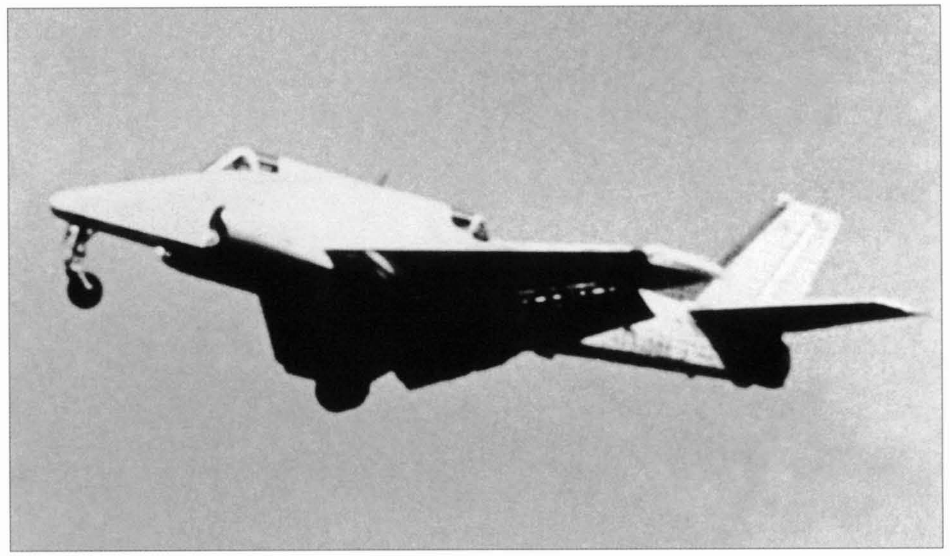
and uneven terrain, make a stealthy approach to the target and reliably identify it. The wing parameters in combination with the thrust/weight ratio, coupled with the availability of airbrakes, made the aircraft capable of performing a banking turn with a radius of only 400 m (1,310 ft); this enabled the pilot to make a second pass without losing sight of the target.

In comparison with the first prototype IL-40, the IL-102's maximum Mach number was reduced from 0.9 to 0.82, while the operational g-load was reduced from 5.45 to 5.0. At the same time more effective airbrakes were fitted. The first prototype IL-40 needed one minute to decelerate from maximum speed to half of this value, whereas the IL-102 used only 45 seconds to bring the speed down from maximum to minimum.

The moderate wing loading, efficient high-lift devices, high thrust/weight ratio and reworked landing gear featuring twin wheels on each main unit, coupled with the thrust-vectoring engines, enabled the IL-102 to operate from *ad hoc* dirt strips in the front-line area. The IL-102's design characteristics included a take-off run of a mere 250-300 m (820-980 ft), while the landing run with the use of reverse thrust was expected to be 300-350 m (980-1,150 ft).

As distinct from Sukhoi's T-8 project, the designers of the IL-102 decided to relinquish the concept of an armour shell protecting all the vital components of the aircraft. Instead, a layout was evolved in which the vital structural elements and units were located in such a way as to provide mutual shielding. Armour plating was used only for the separate crew cockpits fitted with zero-zero ejection seats developed by NPP Zvezda (a standard K-36L for the pilot and a K-36L-102 for the gunner). Also, the engines and the fuel system were provided with partial armour plating. The fuel tanks had no armour protection – from the front and from the rear they were protected by armoured crew cockpits, while from below and from the sides they were shielded by the cannon installation and the engines. In addition, to prevent a fire and explosion, should a tank be pierced by a bullet, the empty space in the tank was filled with explosion-suppression polyurethane foam (as was the case with the Sukhoi T-8, too).

The IL-102 possessed a very potent complement of offensive armament. There were no fewer than 17 hardpoints for the carriage of external stores and chaff/flare dispensers; this enabled the aircraft to use a wide range of weapons. The aircraft's special feature was the versatile armament bays in the fuselage and the wings. The fuselage bay housed the easily detachable NU-102-1 cannon mount which could be deflected to



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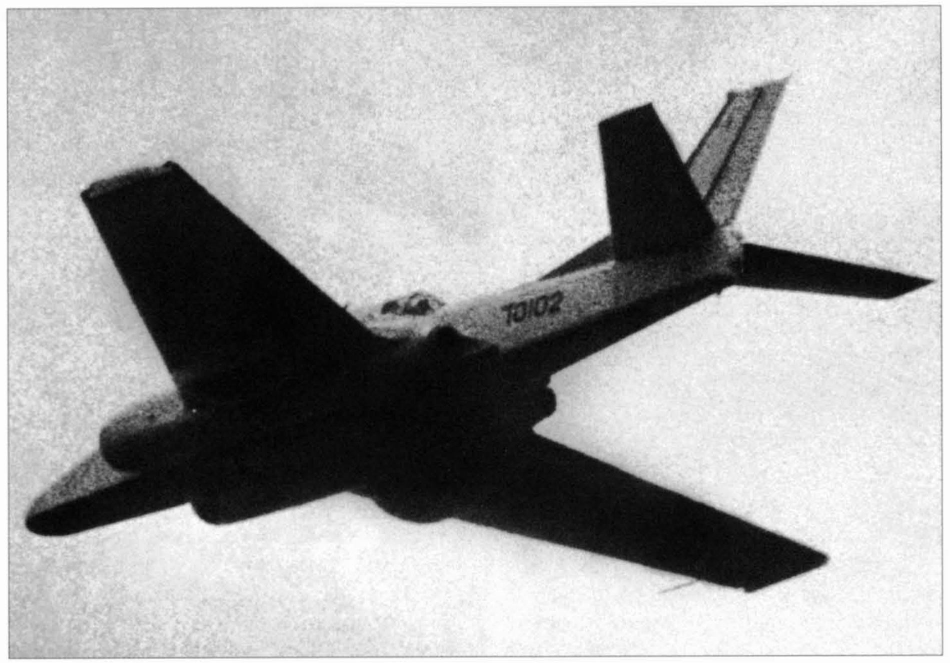

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Top and centre: The first prototype IL-102 makes repeated approaches to Zhukovskiy during a routine test flight. Note the fully deployed flaps.
Above: One more view of '10102' as it makes a high-speed pass with the undercarriage retracted. The IL-102 has few contenders for the title of the Most Ungainly Combat Aircraft.

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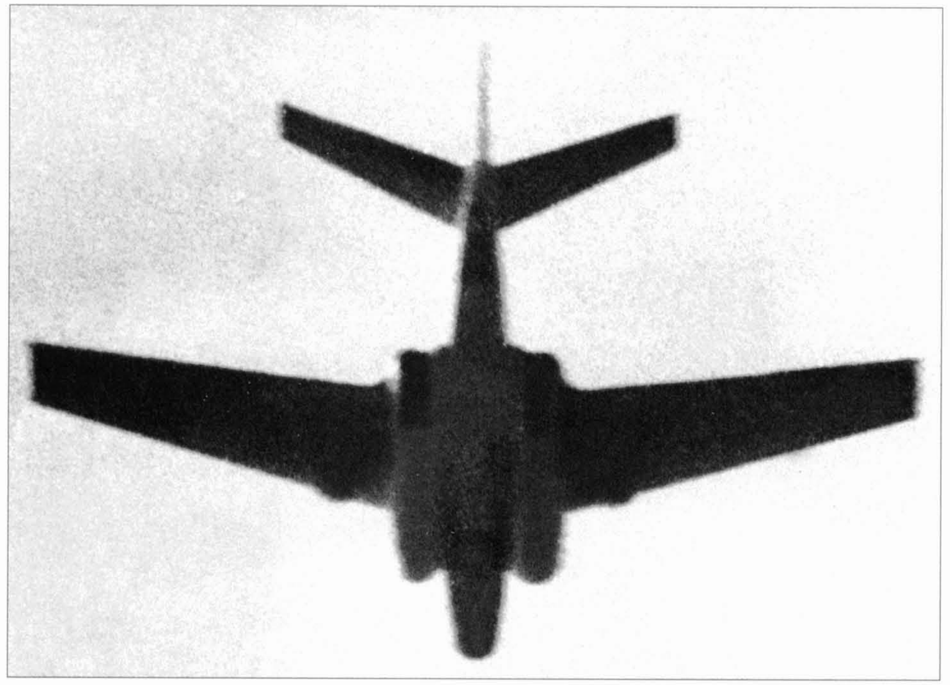
Above: A view of the IL-102 as it passes directly overhead. The main gear fairings appear especially large in this view.

an angle of 15° downwards; it carried the GSh-30 twin 30-mm cannon which had a 1,500-rpm rate of fire.

Eventually the NU-102-1 could also be equipped with a single-barrelled 30-mm (1.18 calibre) or 45-mm (1.77 calibre) aircraft cannon firing shaped-charge rounds intended for destroying heavy tanks. Gun pods housing 12.7-mm, 23-mm and 30-mm weapons could be carried externally under the wings. Bombs weighing up to 250 kg (551 lb) apiece could be carried in six wing bomb bays. The use of internal stowage of the bombs considerably enhanced the aircraft's performance and reduced its radar signature. Six underwing and two underfuselage versatile weapons racks could be used for the carriage of air-to-air and air-to-surface missiles, unguided rocket pods, bombs, gun pods and other weapons.



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Another view of an IL-102 prototype streaking overhead. The large area of the wings and tailplanes makes a striking contrast with the narrow fuselage.

Additionally, two attachment points for the carriage of defensive armament were placed at the downturned wingtips. Mounted here were chaff/flare dispensers and radar warning receiver antennas. All this equipment provided passive protection from ground-to-air missiles with IR and radar homing warheads. Active protection from the rear hemisphere was provided by the tail barbette with a twin-barrel 23-mm cannon remote-controlled by the gunner/operator.

The availability of versatile internal weapon bays incorporated into the fuselage and the wings, and of the external racks, made it possible to modernise the armament complement without introducing changes into the airframe. The weight of the IL-102's rocket and bomb armament totalled 7,200 kg (15,880 lb).

The aircraft was fitted with special equipment enabling it to operate efficiently under all weather conditions in the daytime and at night, making use of the full complement of its armament.

One more special feature of the IL-102 was its ability to operate autonomously and at the shortest possible notice when called into action by the ground forces. Engine starting was catered for by jet fuel starters mounted on each of them; there was a drive from the jet fuel starter to the onboard generator and the hydraulic pump which made it possible to check the units and systems without making use of ground sources of electric power supply. Inbuilt onboard mechanisms for lifting and taking down the weapons and the possibility to lower the fuselage cannon mount for maintenance made it possible to prepare the aircraft for the next sortie very quickly. The IL-102 and its systems were notable for their utmost simplicity in manufacture and maintenance, earning for the aircraft the nickname 'a soldier aircraft'.

Construction of the first prototype IL-102 and a static test airframe began in May 1980. By then the T-8 attack aircraft developed by the Sukhoi OKB had been under test for more than five years, having made its first flight as far back as January 1975.

The first prototype of the IL-102 was intended for assessing the main characteristics of the future combat machine. The second prototype was to be built at a later stage. The intention was to introduce into it design changes and improvements with a view to enhancing its performance and combat capabilities by means of fitting the aircraft with the most up-to-date avionics.

Construction of the first prototype proceeded slowly. In a situation when there was no Government directive endorsing the project, G. V. Novozhilov had to use to the utmost his authority in order to obtain the necessary items of equipment for the aircraft; as for the engines and ejection seats, they were taken 'on loan'. Nevertheless, by early 1982 the manufacture of the prototype was completed. On 20th January Commander-in-Chief of the Air Force, Chief Air Marshal Pavel S. Kutakhov inspected the attack aircraft. A former combat pilot, he gave a high appraisal to the machine and promised to support it in every way. However, it was the Minister of Defence who had the final say in the matter. Once, when Marshal Dmitriy F. Ustinov was paying one of his visits to the Ilyushin OKB, the hosts ventured to show him the new machine, but the Minister, mindful of the previously adopted decision to launching series production of the Su-25 (T-8), refused even to come closer to 'Ilyushin's progeny'. Despite support from Kutakhov the OKB failed to obtain Ustinov's consent to perform full-scale manufacturer's tests of the IL-102 for the purpose of assessing the possibilities of its combat use. Being a member of the Politbureau of the Soviet Communist Party's Central Committee, Ustinov safeguarded his position of one of the highest-ranking officials of the country. His decision was categorical, but his approach was a myopic one. He gave orders to cancel the testing and to destroy the prototype, making it patently clear to Novozhilov that unauthorised initiatives will not be tolerated.

Nevertheless, tacitly supported by Minister of Aircraft Industry Ivan S. Silayev, the General Designer took a decision to conduct manufacturer's tests of the IL-102 at his own risk. In order to conceal the aircraft's role as attack aircraft, it was allotted a new 'euphemistic' in-house designation OES-1 (***o****pytnyy* ***e****xperimen****tal'****nyy* ***s****amo****lyot*** – prototype experimental aircraft).

Bearing the tactical number 10102 and a grey primer finish, the first prototype IL-102 performed its maiden flight on 25th September 1982 from the LII (Flight Research Institute) airfield in Zhukovskiy with the Ilyushin OKB's chief test pilot Stanislav G. Bliznyuk at the controls. V. S. Kruglyakov was appointed project engineer for the test programme, and Nikolay D. Talikov acted as the OKB representative at the tests.

Stage A of the manufacturer's tests intended to determine the aircraft's performance was conducted at Zhukovskiy by test pilots S. G. Bliznyuk and V. S. Belousov. The main design performance figures were corroborated on the whole. The purpose of Stage B of the testing consisted of assessing the influence of firing the cannon, launching missiles and dropping bombs on the aircraft's behaviour, as well as their influence on the pilot and on the functioning of instruments and other onboard systems. Special attention was paid to checking powerplant operation: it was necessary to assess the influence of blast gases during gunnery and missile launches on the reliability of the engine operation. A military airlift regiment stationed in the vicinity of Vitebsk, Belorussia, was chosen as the base for conducting the tests; it was the regiment where flight testing of one of the IL-76 prototypes had been conducted several years before. General N. F. Zaïtsev, the Regiment's commander, and his officers enthusiastically joined in conducting the trials of the new machine and rendered every possible help to the test personnel. A makeshift target range was erected for live testing of the IL-102 weapons on the ground. When firing the cannon, an explosion of gun blast gases occurred in an eerie replay of what had happened earlier to the IL-40. The gases accumulating in the gun bay ignited and blew away the bay cover; a new cover with large ventilation outlets for the gun gases had to be manufactured urgently. After the completion of ground firing tests conducted under the guidance of V. V. Lebedev, it was decided to put the weapons to the test in the air.

The tests showed that the firing of the cannon, thanks to their location on the fuselage undersurface at some distance from the air intake lips, produced no ingestion of gun gases into the engines and, consequently, could not cause their flameout or rpm drop. Nor did missile launches affect engine operation in any way. Gunnery, missile launches and bomb release did not have any adverse effect on the work of the crew, on the instruments and the aircraft's structure.

This firing marked the completion of the IL-102's weapon tests. The test results demonstrated clearly that the IL-102 was a promising machine. This was confirmed by GK NII VVS test pilots Colonels Oleynikov and Migunov who had been invited to take part in assessing the IL-102. The gave a high appraisal to the aircraft and committed their opinion to paper in the report on the test results. After having read the report and listened to the test pilots, the General Designer said that aircraft bearing Ilyushin's name had not received such a high appraisal even in the cases when they were introduced into service with the VVS or Aeroflot.

In the course of manufacturer's testing the IL-102 made 367 flights logging in all 248 hours and 35 minutes. The last flight took place on 29th December 1987. Not a single failure or malfunctioning of onboard systems happened; not a single incident occurred in the course of the testing. Results of the trials confirmed that the attack aircraft met on the whole the operational requirements. The take-off run and landing run proved to be slightly in excess of the stipulated figures, but, on the whole, the performance proved to be very close to the design characteristics.

Should one compare the IL-102 prototype and the production Su-25 which had stood the test of combat operations in Afghanistan, it is difficult to give an objective assessment of the qualities of the former, but some brief comparison of their performance can be made. Judging by the test results, the IL-102 was slightly inferior to the Su-25 as regards manoeuvrability and other performance characteristics; for example, the IL-102's minimum radius of banking turn did not exceed 400 m (1,310 ft). The IL-102 had a higher all-up weight comparable to that of the US Fairchild Republic A-10A Thunderbolt II attack aircraft. Being fitted with more powerful and fuel-efficient engines, it had a higher thrust/weight ratio than the Su-25. The Ilyushin attack aircraft's contours were not quite as clean aerodynamically as those of its rival; this led to extra drag, but at the same time the airframe structure was designed with a view to ensuring a maximum of simplicity and cheapness in production. The two-spar wings of high thickness-chord ratio provided enough space for the internal stowage of a part of the combat load which, in turn, reduced the aircraft's drag. The IL-102 had 16 hardpoints for the suspension of weapons and was capable of carrying a maximum warload of up to 7,200 kg (15,810 lb), which was on a par with the characteristics of the A-10A. The IL-102's radius of action was similar to that of the Su-25. Maximum operational g-load of the IL-102 was 5g – that is, somewhat less than the corresponding figure for the Su-25; naturally, this is an evidence of the aircraft's somewhat inferior manoeuvrability. On the IL-102 the electronic equipment was expected to be installed 'in accordance with the customer's wishes'; yet, in retracted position the nose gear unit was stowed so close to the short nose of the aircraft that it is difficult to say what sort of equipment could be accommodated there. It should be noted that the installation of the second seat for the aft-facing gunner and of the tail barbette increased the aircraft's weight by some 700 to 800 kg (1,540 to 1,800lb). On the basis of tests conducted in the Sukhoi OKB it was demonstrated that the duties of a tail gunner could just as well be performed by the pilot; in this case the aircraft's weight was reduced and the firing could be made more efficient

because the pilot was the first to spot the target and could himself train the tail gun, switching on a device automatically delaying the opening of fire. In turn, the IL-102 had a good view from the cockpit and was superior to the Su-25 in this respect. The Ilyushin machine was fitted with crew emergency escape means just as reliable as those of the Su-25.

The IL-102 attack aircraft, undoubtedly, was an interesting machine; yet, it was slightly inferior to the Su-25. In consequence, it was not adopted for series production and service. There was no unanimous opinion among specialists as to what kind of attack aircraft the Soviet Air Force needed – a single-seater or a two-seat aircraft. Then came the conversion of the military industry to civil production which put an end to this discussion; the IL-102 was parked in a far-off corner of the apron of the OKB's test flight facility in Zhukovskiy.

Interest in the IL-102 was revived in 1992 when the aircraft was displayed statically at the MosAeroShow-92 attracting the attention of thousands of visitors. The aircraft was painted in a green/ brown camouflage and coded 10201; various kinds of ammunition and stores that could be carried by the aircraft were displayed in front of it.

Among those who took a look at the aircraft was Russia's Vice-President, Hero of the Soviet Union Aleksandr V. Rutskoy. Being a former attack aircraft pilot who had done much flying on the Su-25 and had been shot down in this aircraft as a result of a sudden attack from the rear by a Pakistani F-16, he examined the machine and its cockpit equipment very closely. Catching sight of the tail gun, he said: 'That's the kind of aircraft we need! But the calibre of the rear-firing cannon should be increased.'

Correspondence was started with a view to getting under way further development and eventual series manufacture of IL-102, but the failed coup of 1993, in which Rutskoy was one of the dissenters, and his ensuing arrest finally closed all prospects for the IL-102.

IL-102 Specifications

Powerplant	2 x RD-33I
Length overall	17.754 m (58 ft 3 in)
Wing span, m (ft)	16,98 m (55 ft 8½ in)
Height	5,08 m (16 ft 8 in)
Wing area, m² (sq ft)	63.5 (683.6)
All-up weight, kg (lb):	
normal	17,800 (39,250)
maximum	22,000 (48,510)
Fuel load, kg (lb):	
internal fuel only	3,700 (8,158)
with drop tanks	5,630 (12,414)
Max speed at 1,000m	
(3,280 ft), km/h (mph)	950-1,000 (559-621)
Landing speed, km/h (mph)	180 (112)
Practical ceiling, m (ft)	10,000 (32,800)
Range, km (miles):	
maximum	1,000 (621)
ferrying range (w. drop tanks)	3,000 (1,863)
Max. droppable load, kg (lb)	7,200 (15,780)
Cannon armament, calibre (mm)	
offensive	2 x 30
defensive	2 x 23
Take-off run, m (ft)	640 (2,100)
Landing run, m (ft)	600 (1,970)
Crew	2

Structural description of the IL-102

The IL-102 was a two-seat attack aircraft for close support of ground troops; it was configured as a twin-engined low-wing monoplane with thick-airfoil swept wings and swept tailplane.

Fuselage: The fuselage had angular contours with virtually flat sides and a flat bottom. Placed atop the fuselage were the cockpits of the pilot and the gunner/ operator separated by an equipment bay. The gunner's cockpit was aft-facing. The upper forward fuselage sloped downwards, affording a good view to the pilot. The canopies of both cockpits were similar in design, featuring a flat front glazing panel and a hinged part which opened upwards and rearwards (relative to each of the respective crew members). Many vital elements of the aircraft (cockpits, engines) were provided with armour protection or mutually shielded each other. The front and rear cockpits were provided with bulletproof glazing panels.

Wings: Cantilever swept wings of trapezoidal planform, with a thick airfoil section, thanks to which the wing roots could accommodate six bomb bays capable of carrying weapons of up to 250 kg (551 lb) calibre. Placed on the wing undersurface were main landing gear fairings and pylons for the carriage of external stores. The wingtips were angled downwards. The wing trailing edge was occupied by large slotted flaps and ailerons. A pitot tube was mounted on the port outer wing panel.

Tail unit: Conventional cantilever tail surfaces. The vertical tail had a large fin fillet. The high aspect ratio horizontal tail had a trapezoidal planform and marked dihedral; it was mounted at the top of the aft fuselage.

Landing gear: Hydraulically retractable tricycle type. The twin-wheel main units retracted forwards into teardrop-shaped fairings which stood proud of the wing undersurface and were closed by lateral doors. The single-wheel nose unit retracted aft into the forward fuselage. The undercarriage design permitted the aircraft to be operated from dirt strips with a bearing strength of 5 kg /cm² (71 lb/sq in).

Powerplant: Two Klimov (Izotov) RD-33I non-afterburning turbofans, each rated at 5,200 kgp (11,470 lbst) for take-off. The engines flanked the fuselage and had individual air intakes protruding beyond the wing leading edge. The nozzles could be deflected downwards both at take off and in horizontal flight.

Fuel system: The internal fuel tanks had a total capacity of 3,700 kg (8,158 lb); together with auxiliary drop tanks the total fuel load amounted to 5,630 kg (12,414lb). To prevent a fire and explosion if pierced by bullets, the fuel tanks were filled with explosion-suppression polyurethane foam.

Armament. The cannon armament comprised the NU-102-1 underfuselage flexible cannon installation (it could be deflected downwards to 15°); the cannon installation included a 30-mm GSh-30 twin forward-firing cannon with an ammunition load of 500 rounds. It was supplemented by the flexible 23-mm GSh-23 twin cannon in a tail barbette remote-controlled by the gunner/operator. There was a provision for the carriage of two gun pods as underwing external stores.

Missile and bomb armament could be carried at 14 attachment points (six in the wing bays, six under the wing and two under the fuselage). It included:

bombs weighing 100 to 500 kg (220-1,102 lb) apiece;

pods with 57-mm, 80-mm and 130-mm unguided rockets;

KMGU submunitions dispensers;

air-to-surface missiles;

R-60M and R-73 air-to-air infra-red homing missiles;

other types of weapons.

The total warload was 7,200 kg (15,780 lb), of which 2,300 kg (5,070 lb) could be carried internally.

Avionics and equipment: The IL-102 was fitted with a navigation/attack avionics suite permitting the aircraft to be operated efficiently under all weather conditions round the clock. The pilot's cockpit was fitted with the S-17BTs collimating sight; provision was made for the use of a gun-laying radar and of optoelectronic sighting systems. The gunner/operator was provided with the KPS-53-A sighting system which included the PAU-475-2M gunsight with a rangefinder and a calculator.

Chaff and flare dispensers could be mounted at the wingtips.

Crew rescue system: The aircraft was fitted with two zero-zero ejection seats: a Zvezda K-36L for the pilot and a K-36L-102 for the gunner.

2 BOMBERS

DB-3 and IL-4 long-range bombers

In the early 1930s the backbone of the Soviet long-range bomber force was formed by TB-3 heavy bombers designed by Andrey N. Tupolev. With a normal bomb load of 1,000 kg (2,205 lb) the aircraft had a range of 2,200 km (1,367 miles) at a cruising speed of 180-200 km/h (112-124 mph). Five movable machine guns protected the TB-3 from attacks by enemy fighters. At the time of its introduction into the Red Army Air Force (VVS) inventory the TB-3's performance was sufficiently high, but the rapid development of the aircraft industry, the increasing speed performance of combat aircraft (especially fighters) and the general increase in the efficiency of air defences led the Soviet aircraft industry to start work in 1932-33 on a new long-range bomber to replace the TB-3 in the second half of the 1930s. The operational requirements for such an aircraft included a range of 3,000 km (1,864 miles) with a 1,000-kg (2,205-lb) bomb load and a maximum speed of no less than 350 km/h (217 mph) at optimum altitude. Tupolev set about designing the DB-2 (***dahl'niy bombardirovshchik*** – long-range bomber) to meet these requirements.

Sergey V. Ilyushin had rather different ideas regarding the new generation long-range bomber. After studying the problem he concluded that a bomber having the specified maximum speed would be useless for attacking targets deep in the enemy's rear, owing to the increasing speeds of advanced new fighters which could go as fast as 400-450km/h (248-279 mph). A long-range bomber should be capable of comparable speeds.

This approach came to be implemented in a rather roundabout way. In 1933-34 Ilyushin, in his capacity of the chief of the Central Design Bureau at Plant No.39 and the leader of one of its design teams, was engaged in projecting a high-speed short-range bomber designated BB-2 (***blizhniy bombardirovshchik*** – short-range bomber). This design, which competed with Tupolev's SB (ANT-40), was eventually transformed into a long-range bomber. But prior to that the BB-2 underwent its own evolution. Its turning point was the acquisition of licenses to manufacture French aircraft engines in the USSR. These included the Gnome-Rhône Mistral Major 14Kdrs radial (often referred to as K-14 in the USSR). This promising engine produced 500 hp at 3,850 m (12,600 ft), weighed only 600 kg (1,320 lb), had a small frontal area and was quite fuel-efficient. In 1934 it entered production in the USSR as the M-85, its updating being conducted under the leadership of A. Nazarov. The availability of this engine gave new impetus to the work on the BB-2. Originally intended to be powered by Mikulin M-34 liquid-cooled 12-cylinder engines, it was redesigned to accept the new powerplant. Accordingly designated BB-2 2K-14, the aircraft was known in-house as the TsKB-26. Simultaneously, Ilyushin was working on a project of a passenger aircraft having much in common with the mentioned bomber, but this project enjoyed low priority and was eventually abandoned.

Meanwhile, construction of the TsKB-26 prototype began in June 1934; concurrently, construction of a full-scale mock-up proceeded at a somewhat quicker pace, providing the basis for testing various features before they were incorporated in the prototype. The BB-2 mock-up officially endorsed in December 1934 was virtually identical to the prototype TsKB-26 under construction.

At that juncture matters took a sudden turn. Tupolev's SB was adopted for series production; logically enough, the rival BB-2 design was now considered superfluous and was about to be eliminated from the list of aircraft in the prototype construction plan. Ilyushin reacted promptly to this turn of events. He successfully defended the case for continuing the work on the TsKB-26 by presenting it as a long-range bomber meeting the same specification as Tupolev's DB-2 (ANT-37).

While some researchers tend to regard this as a brilliant improvisation, others present this as a result of foresight. They point out that concurrently with the work on the short-range bomber, Ilyushin conducted at his own initiative, within the framework of the same project, studies on a high-speed long-range bomber powered by M-85 radials. Actually, the TsKB-26 embodied from the outset some features which made it easily adaptable to the new role.

The new long-range bomber design was rather unorthodox for its time. The long-range bombers developed in the first half of the 1930s had wings with low loading and a high aspect ratio, giving a reduction in induced drag and an increase in range. Sergei Ilyushin considered that long range could also be attained by a high speed aircraft having wings of medium aspect ratio with a thin bi-convex aerofoil section and reduced area, owing to the increased wing loading. He therefore designed for his bomber a special wing with a low aspect ratio of 7, a high loading of 140kg/m² (28.5 lb/sq ft) and a low thickness/chord ratio. To improve field performance special TsAP-type control surfaces were used. High aerodynamic efficiency was achieved by having a small fuselage mid-section, an internally housed bomb load, smooth wing/fuselage junction, retractable undercarriage, smooth airframe skinning and carefully designed engine cowlings.

TsKB-26 bomber prototype

The TsKB-26 was not a long-range bomber prototype, however, but an experimental version of the aircraft – a proof-of-concept vehicle. To produce the TsKB-26 as quickly as possible it was given a composite struc-

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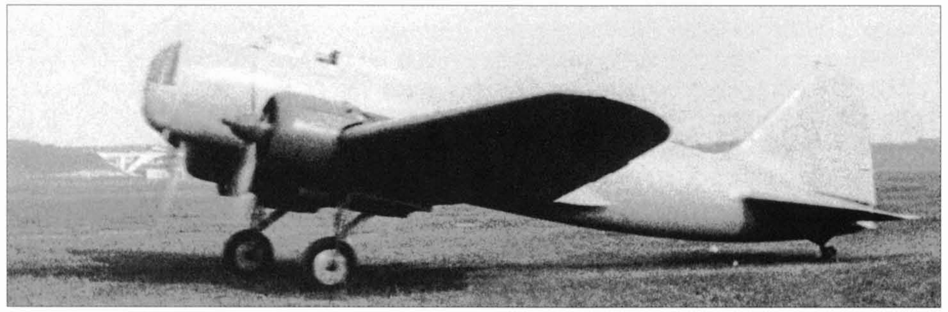
Silver doped overall and completely devoid of markings, the TsKB-26 lifts its tail as it takes off. The one-piece forward-sliding cockpit canopy is fully open, making the very short nose appear even shorter.



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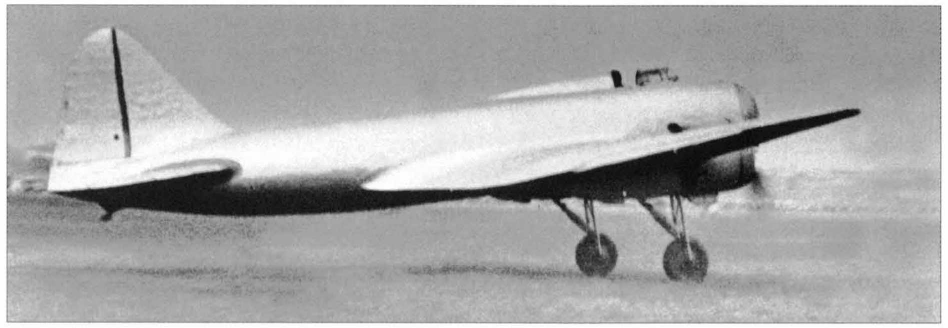
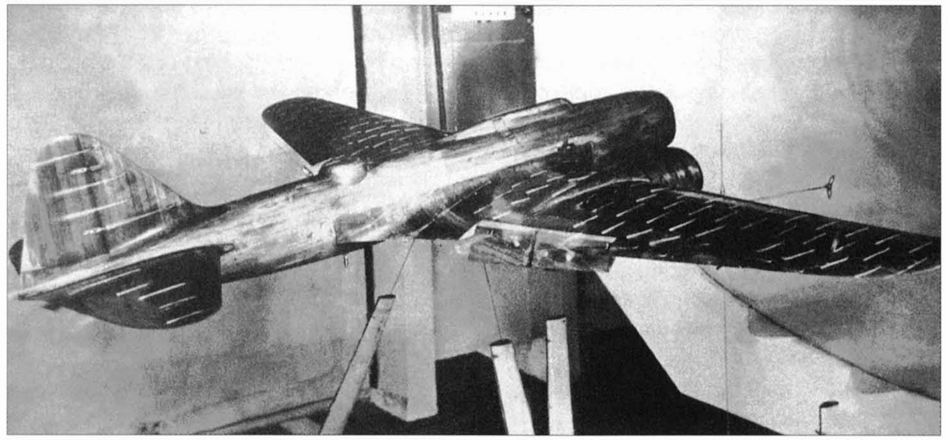
Above and below: Two views of the TsKB-26 during tests. Note the shape of the nose glazing, the lack of a dorsal turret and the tailskid; in the upper photo the latter is replaced by a small fixed tailwheel.



Boris Vdovenko

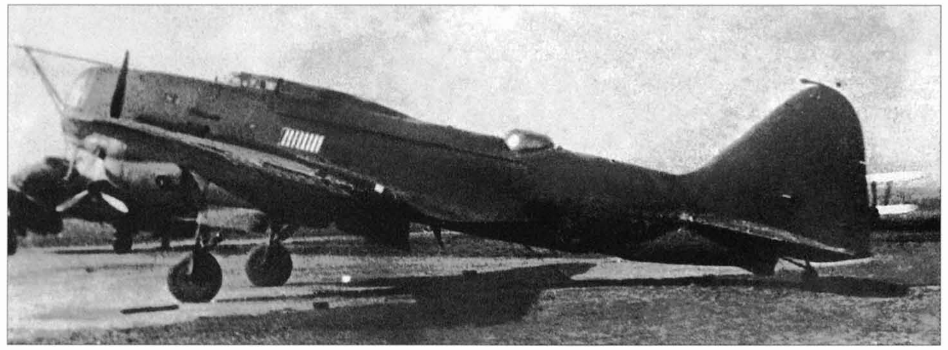
ture: the fuselage and fin were wooden, while the wings and horizontal tail were of metal construction.

Test pilot Vladimir Kokkinaki performed the maiden flight in the summer of 1935. The test flights proved that the aircraft had a high performance, especially with regard to speed, compared with the DB-2 (ANT-37) prototype, which was suffering flutter and buffet problems. The TsKB-26 was also characterised by good stability and controllability. It could fly on one engine and was highly manoeuvrable (the first loop by a twin-engined aircraft in the Soviet Union was performed by Kokkinaki in the TsKB-26). This was possible because of the high strength of the aircraft's primary structure, which Sergei Ilyushin had designed to take high g loads, foreseeing the inevitable growth of the all-up weight owing to increases in defensive armament and the installation of additional equipment. The TsKB-26 was demonstrated to People's Commissars Klim Voroshilov (defence) and Sergo Ordzhonikidze (heavy industry) in the late summer of 1935. They appraised the aeroplane highly, urging Ilyushin to submit the second prototype – the all-metal TsKB-30 – for official State acceptance tests as quickly as possible, because it met the Red Army Air Force requirements completely.



Ilyushin Aviation Complex

Above: A wooden model of the DB-3 (note the dorsal turret) in one of TsAGI's wind tunnels. Note the deployed flaps.



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This is probably the TsKB-30 (DB-3 prototype) during tests, with the Bartini Stal'-7 airliner visible beyond. Note the longer nose (topped by a pitot boom for test purposes), the rudder mass balance and the larger wheels.

Development of the TsKB-26 was rather protracted. On 1st May 1936 it flew over Moscow's Red Square during the May Day parade, and preparations to attempt record-breaking flights, initiated by Iosif V. Stalin himself, began soon afterwards. The Soviet Union had just become a member of the FAI (*Fédération Aéronautique Internationale*) and was seeking world records. On 17th June 1936 Vladimir K. Kokkinaki reached an altitude of 11,294 m (37,053 ft) with a 500-kg (1,102 lb) payload, thereby gaining the USSR's first aviation world record. Kokkinaki beat the previous record held by the French pilot Signerin by 919 m (3,015 ft). By August 1938 Kokkinaki had taken five more world records for payloads from 500 kg (1,102 lb) to 2,000 kg (4,410 lb) and speed over a 5,000-km (3,107-mile) closed circuit.

TsKB-30 bomber prototype

In March 1936 the second prototype, the TsKB-30, was rolled out. Unlike the TsKB-26, this aircraft was built to the official BDD (*bombardi**rov**shchik **dal'**nevo **dey**stviya* – long-range bomber) specification. It differed from the TsKB-26 in having an all-metal fuselage with an extended nose, an aft-sliding cockpit canopy with a fixed windscreen (the TsKB-26's one-piece forward-sliding canopy could cause problems in an emergency) and improved cowlings for the M-85 engines; the aircraft was fully armed and equipped. When tested by Kokkinaki it displayed high performance. At an all-up weight of 6,400 kg (14,110 lb) the TsKB-30 reached 335 km/h (208 mph) at sea level and 415 km/h (257 mph) at 4,800 m (15,750 ft), while the landing speed was 110 km/h (68 mph). It took 12.8 minutes to climb to 5,000 m (16,400 ft) and had a service ceiling of 9,060 m (29,750 ft). The aircraft successfully underwent State acceptance trials and was introduced into the VVS inventory in August 1936 under the DB-3 designation.

The DB-3 represented the acme of aircraft design in the Soviet Union on the eve of the introduction of the pattern manufacturing technique in the aircraft industry. The DB-3's structure was similar to that of the Tupolev SB, but the spar tubes were made

of chrome/molybdenum steel. Each wing panel spar consisted of four parts riveted together to make the complete spar, and their production was a difficult process. The quality of welding was controlled by an X-ray machine, which revealed a number of defective spars. The internal riveting of small-diameter tubes was also a very difficult and slow process.

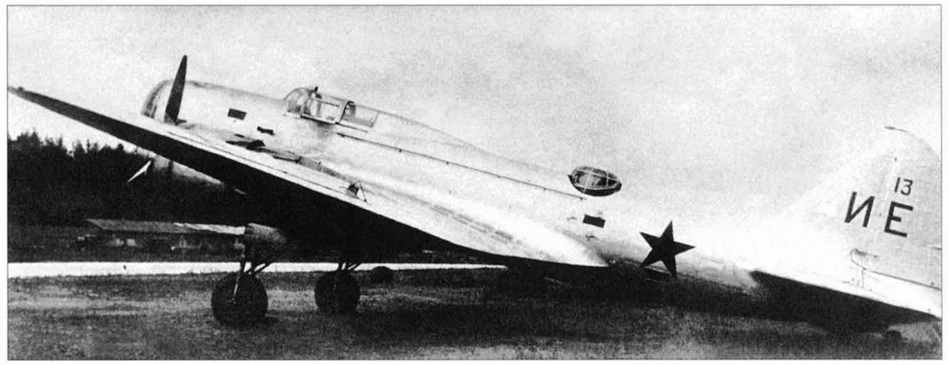
The wing structure was complex but rigid and sufficiently light. The fuselage was simpler but used frames of varying profiles. Many small welded units were required. The well-designed bomb bay located behind the pilots cockpit was equipped for carrying ten 100 kg (220-lb) bombs. External bomb racks could take large-calibre bombs of 500 kg (1,102 lb) and 1,000 kg (2,204 lb); this allowed the aircraft to be used as a short-range bomber in overload configuration, with a bomb load of 2,500 kg (5,510 lb) – a record figure for twin-engined aircraft at the time. In accordance with the operational requirements the aeroplane was designed for a crew of three.

The defensive armament comprised three movable 7.62-mm (.30 calibre) ShKAS machine guns providing the highest rates of fire in the world at the time. The navigator's gun protecting the forward hemisphere was placed in the extreme nose; the rear hemisphere was defended by the gunner in the rear cabin, using machine-guns in a dorsal turret and a ventral hatch.

DB-3 2M-85 (DB-3S) production bomber

The DB-3 went into production at Plant No.39 in Moscow and Plant No.18 in Voronezh. To refine the bomber during series production, Plant No.39's experimental workshop was transformed into a design bureau, with Sergey V. Ilyushin as Chief Designer. This was just a formality, since by then the Ilyushin OKB had already been formed as a united team of designers capable of solving various problems concerning the development and updating of advanced combat aircraft.

From May to October 1937 pre-production DB-3 (c/n 3039002 – that is, TsKB-30 built by plant No.39, 002nd example built) underwent State acceptance tests at NII VVS. Its performance proved to be slightly inferior to that of the prototype. At a weight of 6,600 kg (14,550 lb) it had a sea level speed of 325 km/h (201 mph), attained 390 km/h (242 mph) at 5,000 m (16,400 ft) and reached its service ceiling in 46 minutes. Thus the DB-3 considerably outperformed Germany's Junkers Ju 86D and even the new Heinkel He 111B then under test at the Rechlin test centre. The He 111B was 6.2-12.4 mph (10-20 km/h) slower at all altitudes



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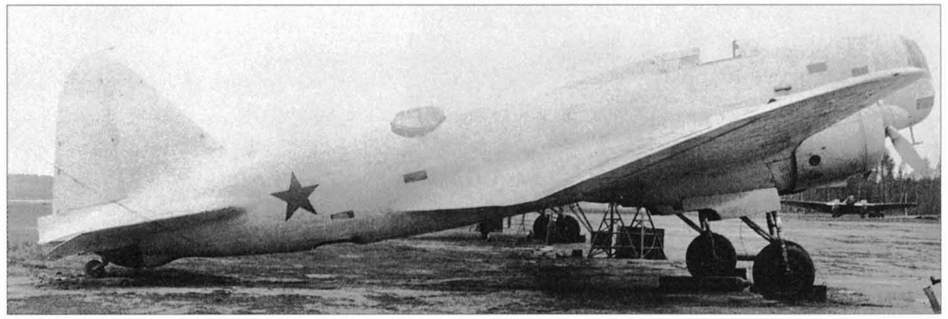
Above: An early-production DB-3 2M-85 used for test work. The Cyrillic letters IE on the tail signify that the aircraft belonged to the People's Commissariat of Aircraft Industry. Note the modified cockpit canopy with increased glazing area, the handrail along the fuselage and the serial '13' (uh oh...).



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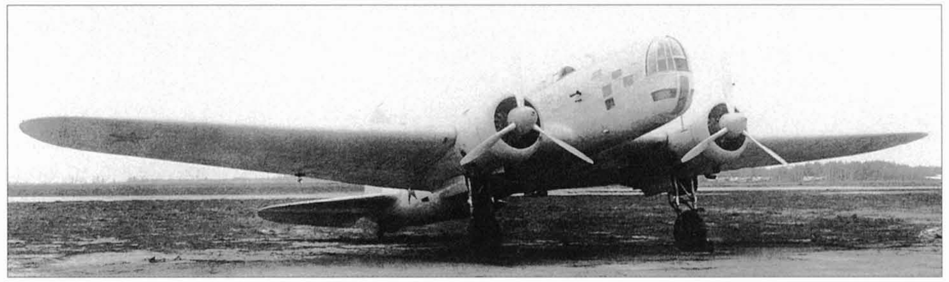

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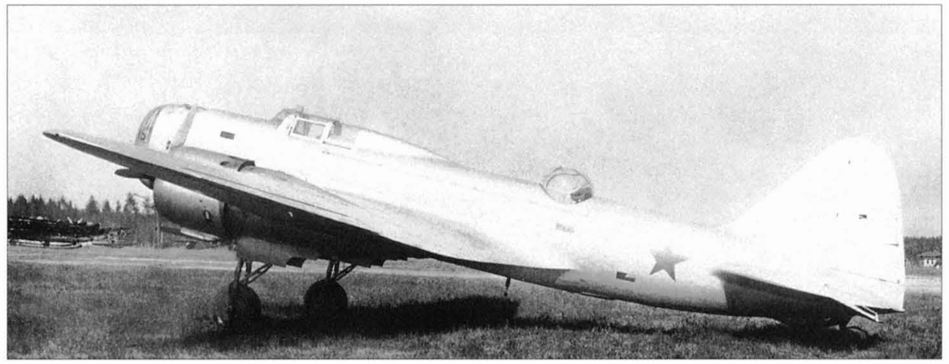
Two views of a typical production DB-3 2M-85 with a flat-topped SU dorsal turret. The design of the navigator's station glazing and the small side windows are clearly visible. The sliding cockpit hood is missing.



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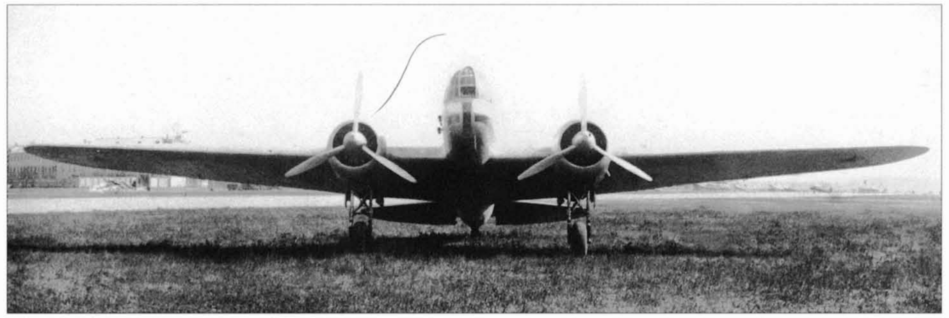

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Two views of a DB-3 2M-87B equipped with a Mozharovskiy/Venevidov MV-3 'ball turret'. Before the war, the DB-3s left the factory in this overall silver finish; camouflage took some time coming.

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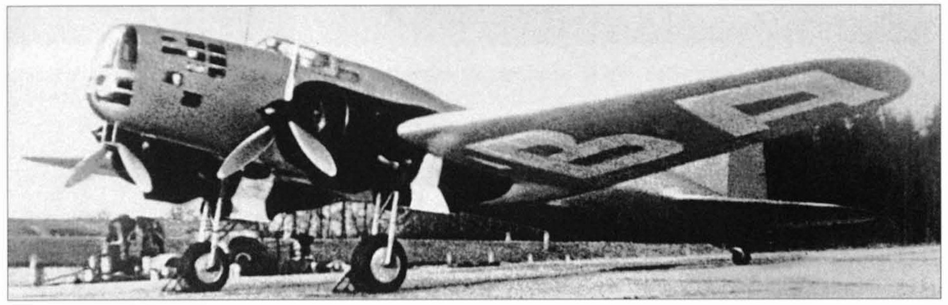

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Top and above: In 1938 the TsKB-30 prototype was modified for a long-distance record attempt. Note the larger nose glazing area. The legend across the underside of both wings reads MOCKBA ('Moskva' in Cyrillic).

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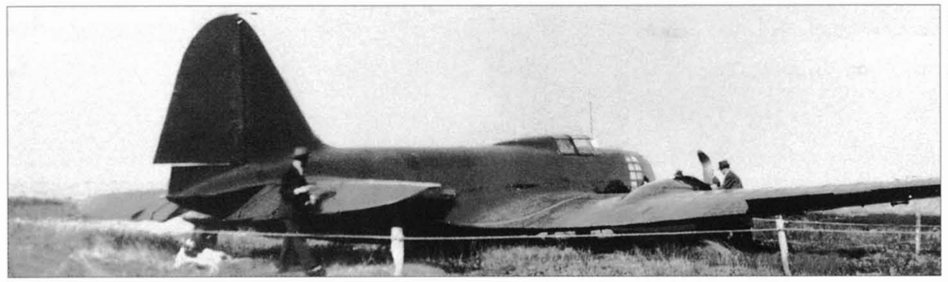

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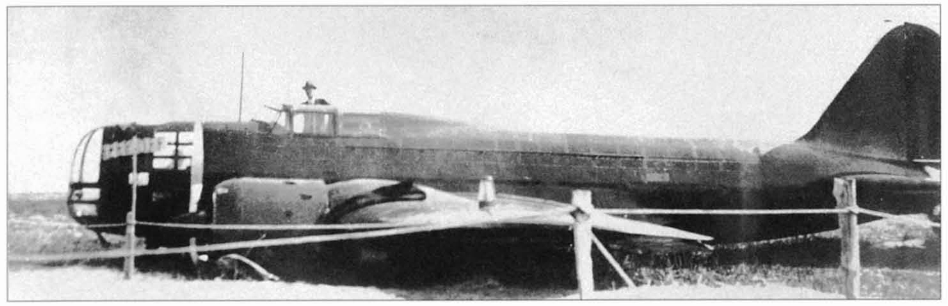

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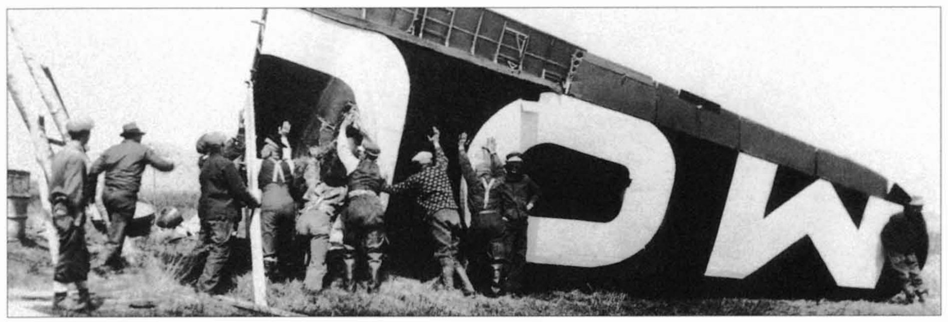

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From 28th to 29th April 1939 the Moskva covered 8,000 km non-stop from Moscow to Miscoe Island, USA, but bit the dust during landing. In the bottom photo it is dismantled for recovery. Note the lack of the dorsal turret.

and its service ceiling was 1,400 m (4,600 ft) lower, while its armament was the same and controllability and stability were better.

Not only were the DB-3's aerodynamics excellent, but its fuel and oil capacity were equal to one-third of its maximum take-off weight. As a result, it had ranges of 4,000 km (2,485 miles) with a 500-kg (1,102-lb) bomb load and 3,100 km (1,926 miles) with a 1,000-kg (2,205-lb) load, while the He 111B managed only 1,660 km (1,031 miles) with 750 kg (1,653 lb) of bombs and 910 km (565 miles) with 1,500 kg (3,306 lb). Early in its successful life the DB-3 gained the high appreciation of its pilots. Particularly notable were its easy take-off, rapid climb, good stability without any suggestion of yaw, steady level flight (which made it a good bombing platform), tight turns with 40° to 60° bank, and easy landing approach. It had no dangerous tendencies, such as rapid loss of speed, wing stall and arbitrary ballooning during landing. The DB-3 also had good single-engine capabilities; at a normal AUW of 7,000 kg (15,430 lb) it could climb and turn in both directions on one engine. However, pilots noted a lack of longitudinal stability owing to the aft CG position.

In 1937, with the help of a number of Ilyushin OKB designers, including A. Belov, V. Biryulin, M. Yefimenko and A. Levin, the two plants manufactured 45 DB-3s, and that year the DB-3 powered by M-85 engines was introduced into the inventory of the VVS. (According to some sources, the initial production model was sometimes referred to as DB-3S – *seriynyy*, series-built). It considerably outperformed similar bombers built in Germany, England, France and the USA.

TsKB-30 Moskva record-setting aircraft

The DB-3's high performance, especially with regard to range, was proved in the course of two long-range flights performed by the modified TsKB-30 prototype, now named *Moskva* (Moscow), in 1938-39. The modification included removal of all armament. In the second mission flown from 28th to 29th April 1939, pilot V. K. Kokkinaki and navigator M. Kh. Gordiyenko covered 8,000 km/4,971 miles (6,515 km/4,048 miles in a straight line) non-stop at an average speed of 348 km/h (216 mph). This was a significant achievement for Soviet aviation at that time. The Moskva's long distance flights greatly influenced the development of the DB-3's airframe, engines and equipment. Moreover, flights by Kokkinaki and many other Soviet pilots enabled piloting techniques for long range flights to be developed and revealed the crew fatigue limits. These aspects also promoted efficient weather survey and communication services.

Ilyushin Aviation Complex

Above: The demilitarised TsKB-30 N-2 record-setting aircraft bore the name Ookraïna (the Ukraine). Note the compressed air bottle used for engine starting, the further enlarged nose glazing and the twin Venturi tubes.

TsKB-30 N-1 and TsKB-30 N-2 Ookraïna record-setting aircraft

In 1939-1940 two production examples of the DB-3 2M-87B were specially modified with a view to establishing women's world records: a closed-circuit speed record and a range record. The modified aircraft differed from the TsKB-30 Moskva only in having the emergency flotation equipment deleted, but the crew was raised to three. They were known as TsKB-30 N-1 and TsKB-30 N-2. One of these machines (the N-2) piloted by an all-woman crew was to attempt a range record on the Moscow-Sverdlovsk (now renamed back to Yekaterinburg)-Sevastopol'-Moscow closed-circuit route. The aircraft started on this flight on 5th June 1940, but the attempt ended in a failure. The crew had to force-land in Sverdlovsk when an engine cut because of an oil leak.

The other machine was intended for a flight along the Khabarovsk-Tobol'sk-Sverdlovsk-Moscow-L'vov route spanning over 7,500 km (4,661 miles) which would be a considerable improvement compared to the previous (also Soviet) women's record of 5,908.6 km (3,672.2 miles). The aircraft, christened *Ookraïna* (the Ukraine), was ferried to Khabarovsk. On 27th July the crew captained by M. Nesterenko set off on the record flight. However, the elements conspired against the brave crew. Extremely harsh weather conditions on the route eventually led the organisers to order the termination of the flight before its goal was reached. The aircraft made a belly landing on a field in the Kirov Region (west of the Ural mountains) having covered a distance of 5,500 km (3,418 miles).

DB-3 2M-86 (DB-3A) production bomber

These record flights contributed to elevating the combat capabilities of Soviet long range aviation, based at that time on different variants of the DB-3, which was constantly being improved. In 1938 the M-85 engine was replaced by the M-86 with an augmented rating of 950hp. This allowed the DB-3's good take-off performance to be retained in spite of increased weight. The maximum speeds at various altitudes remained the same. Introduction of the M-86 engine was the main element of the first stage (Stage A) of a three-stage (A, B, V, in Cyrillic alphabetical sequence) upgrading programme for the DB-3; accordingly, the M-86-powered version is sometimes referred to as DB-3A. Different batches of this version

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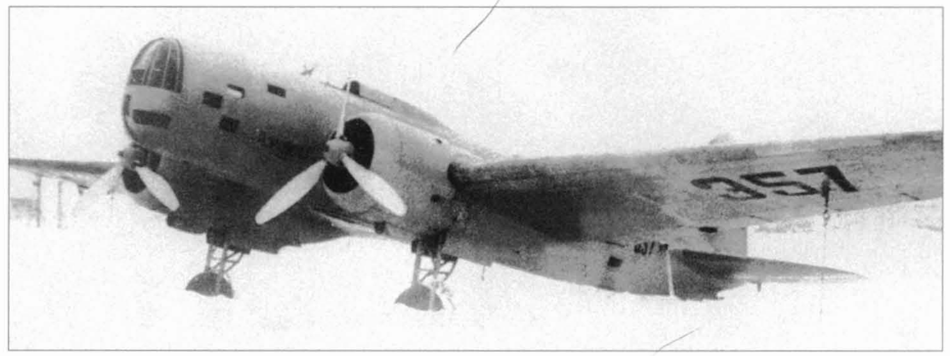
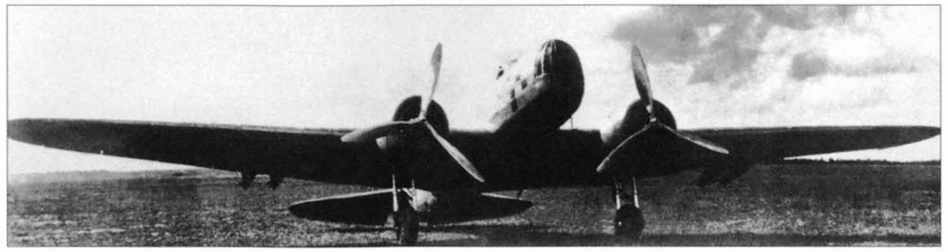


This demilitarised DB-3 bearing the civil registration CCCP-Э 57 (ie, SSSR-Eh 57) was operated by NKAP, as the Eh suffix indicates. Note the Aeroflot titles on the nose.



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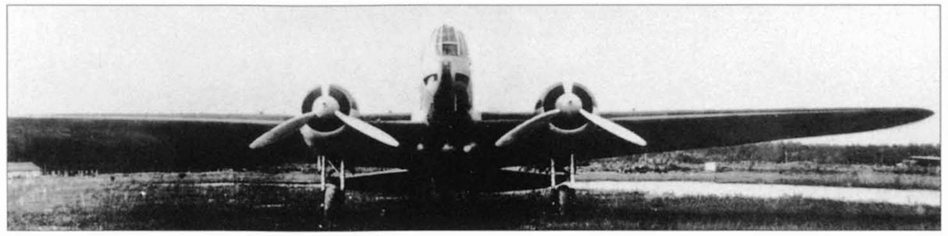
Above: A DB-3 equipped with four UKhAP chemical warfare liquid dispensers under the outer wings.



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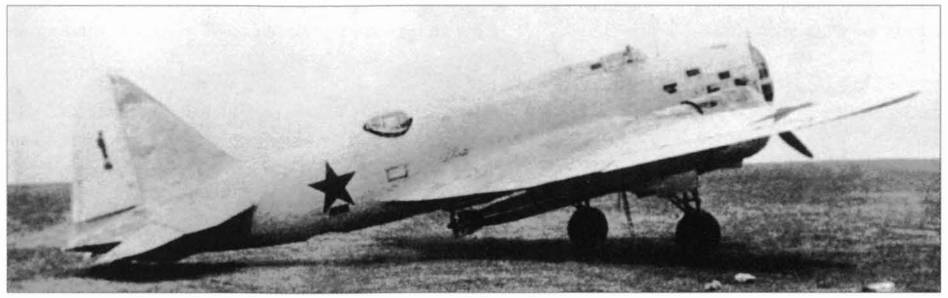
Above: A DB-3 carrying three long-range fuel tanks under the fuselage.

RART

Above: The TsKB-53, the prototype of the DB-3T torpedo-bomber version



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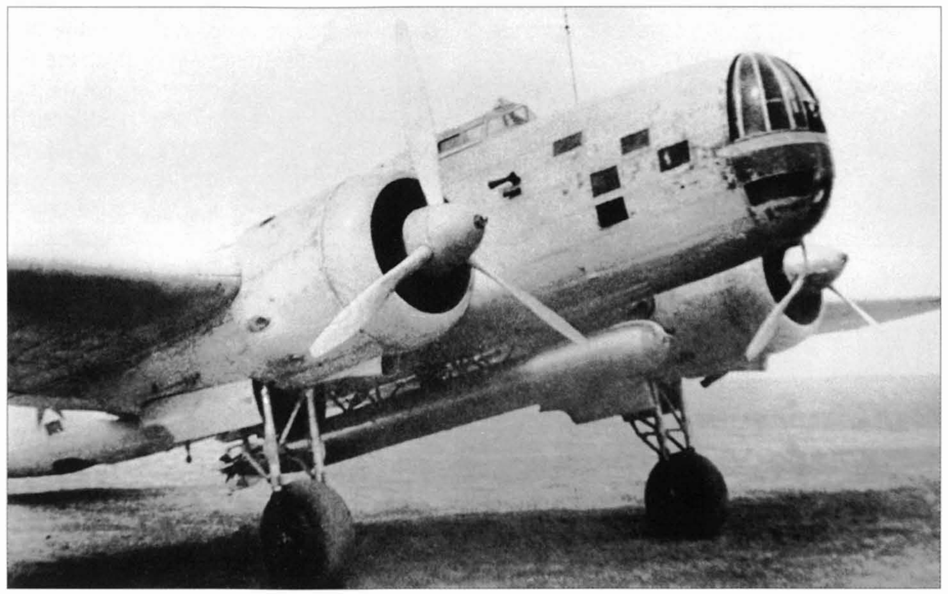


RART

Centre and above: Two more views of the TsKB-53 with a Model 45-36 torpedo under the fuselage.

incorporated a number of detail improvements gradually introduced on the production line.

DB-3 2M-87A (DB-3B) production bomber

From 1938 onwards the bomber's speed was increased by the installation of M-87A engines and the use of VISh-3 variable-pitch propellers instead of fixed-pitch units, which meant that engine power was used to best advantage during different phases of flight. The M-87A, which had the same take-off power as the M-86, provided 800 hp at an altitude of 4,700 m (15,500 ft). This was done within the framework of stage B of the upgrade programme; hence the M-87A-powered DB-3s were also unofficially known as DB-3B. (Stage V was later skipped in favour of the DB-3F). The transition to the B model was gradual, various modifications being introduced from batch to batch.

During tests at NII VVS early in 1939, two bombers produced at Plants Nos.18 and 39 demonstrated improved performance. At an all-up weight of 7,200-7,800 kg (15,870-17,195 lb) their sea level speeds were equal to 428-436 km/h (265-270 mph) at a critical altitude of 4,960 m (16,300 ft). The service ceiling had increased to 9,200-9,300m (30,200-30,500ft), and the time to climb to 5,000 m (16,400 ft) was 10.7 minutes. The take-off run was 350-400 m (1,150-1,310 ft) and the maximum overloaded weight had risen to 9,696 kg (21,375 lb). In the final test report it was noted that the aeroplanes produced by Plant No.39 were of higher quality. In 1938 another factory, No.126 in Komsomol'sk-on-Amur, also switched to DB-3 production, increasing the output by 400 aircraft.

DB-3 2M-88 production bomber

The last production batches of the DB-3 manufactured in the second half of 1940 were fitted with M-88 radials with a take-off rating of 1,100 hp. The increased power led to some improvement in performance, the maximum speed reaching 429 km/h (267 mph) at 6,800 m (22,310 ft). This was the last baseline version of the DB-3 which was superseded in production by the radically modified DB-3F.

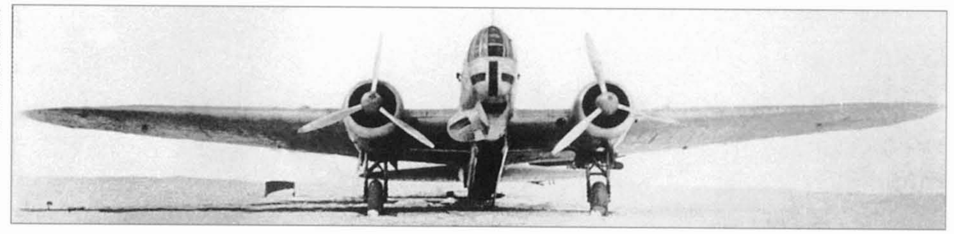
DB-3T (TsKB-53) torpedo bomber

The Ilyushin Design Bureau constantly extended the applications of the DB-3. In 1937 it produced a naval torpedo-bomber version which had the in-house designation TsKB-53 and service designation DB-3T (*torpedo**nos**ets* – lit. torpedo carrier). By virtue of special external attachment points it could carry a Model 45-36 torpedo (the first number denoted the torpedo's calibre (45 cm/ 17¾ in), the second its year of introduction into the inventory) with a 200-kg (440-lb) warhead and a total weight of 940 kg (2,070 lb). The DB-3T was equipped to enable weapon delivery, using either low or high torpedo-bombing methods. In the first case the 45-36 AN torpedo (AN = *aviatsionnaya, nizkovysotnaya* – aerial, low-altitude) was dropped at 30 m (100 ft) and 320 km/h (198 mph). It was forbidden to drop the torpedo at lower or higher altitude because its casing could break in two when it hit the water or it could sink too deep. Although low-altitude torpedo bombing offered the highest 'kill' probability, it demanded a high degree of flying skill and good aircraft handling and manoeuvrability. In high-altitude torpedo bombing the DB-3T dropped the 45-36 AV torpedo (AV = *aviatsionnaya, vysotnaya* – aerial, high-altitude) from 300 m (1,000 ft). The torpedo was parachuted down, and after splashdown it began to travel in a circle on the target's course. In addition to the torpedo, the DB-3T could carry the usual bomb load and could be used as a bomber or for dropping anti-shipping mines. It could also serve as a long-range maritime reconnaissance aircraft. The DB-3T aircraft were produced on the basis of versions powered by M-86 and M-87 engines. In addition to the standard production version of the DB-3T carrying the torpedo externally, the OKB produced a prototype version in which the torpedo was enclosed by a large underfuselage fairing heated by exhaust gases. This version was not adopted, primarily because it precluded the use of the aircraft in the bomber role.

Introduced into the Soviet Naval Aviation inventory, the DB-3T became the first mass produced Soviet torpedo-bomber, fully meeting the operational requirements. On its technical basis a new aspect of Naval Aviation, Torpedo Aviation, was born in 1939-1940 for the destruction of enemy vessels by torpedoes and bombs, and also for mining enemy seaways and exits from naval bases.

DB-3TP (TsKB-51) torpedo floatplane

However, the DB-3T could take off only from land bases, and sometimes these were not readily available, especially in the areas covered by the Northern Fleet. In 1938, therefore, a new version, the DB-3TP (*torpedonosets poplavkovyy* – torpedo-bomber floatplane, sometimes called DB-3PT) was designed. It was known in-house as TsKB-51. The floats, taken straight from the Tupolev TB-1P, naturally reduced the torpedo-bomber's performance. During tests in the summer of 1938 at a normal flying weight of 7,550 kg (16,640 lb) and carrying a torpedo, the DB-3TP reached a speed of 343 km/h (213 mph) at 4,000 m (13,120 ft),



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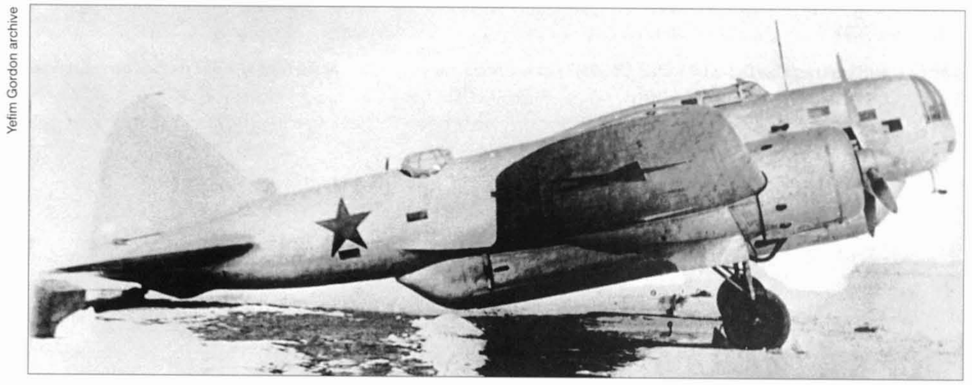
Above and below: An experimental version of the DB-3T with an external torpedo housing. Note that the nose fairing of the housing swings open together with the crew entry hatch and features a sighting window.



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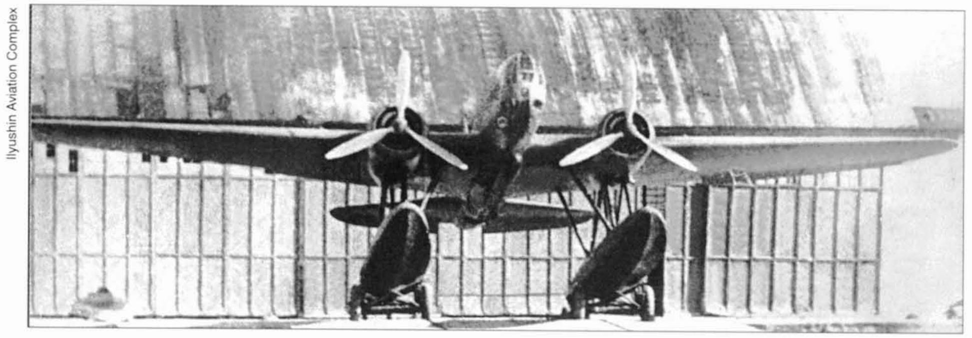

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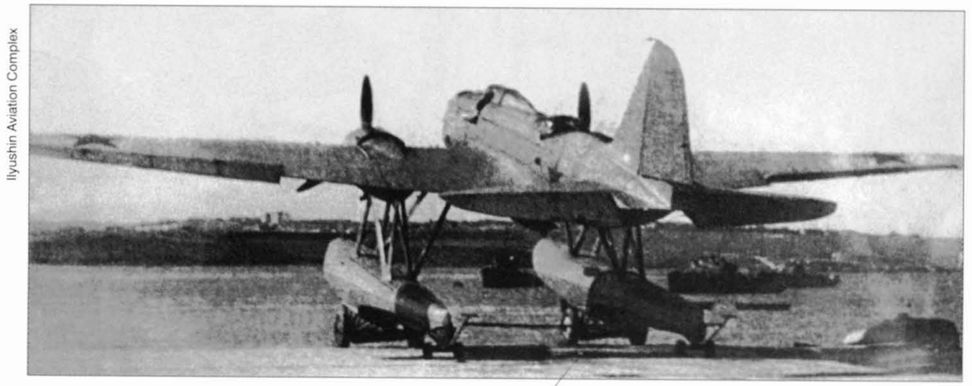

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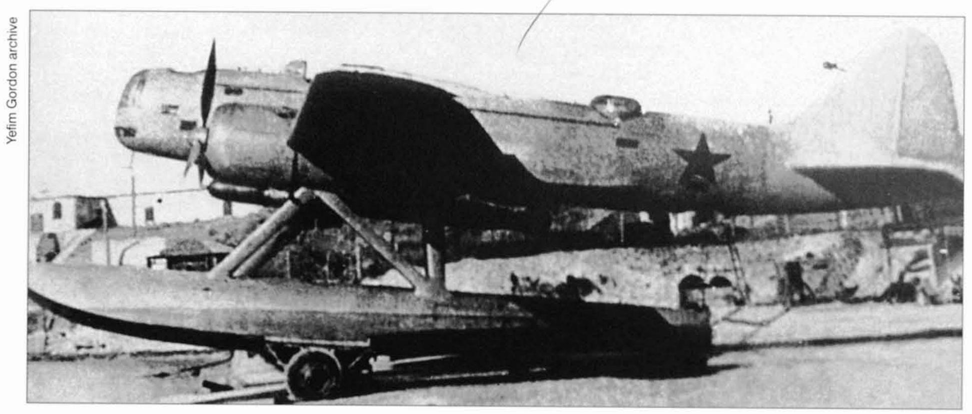

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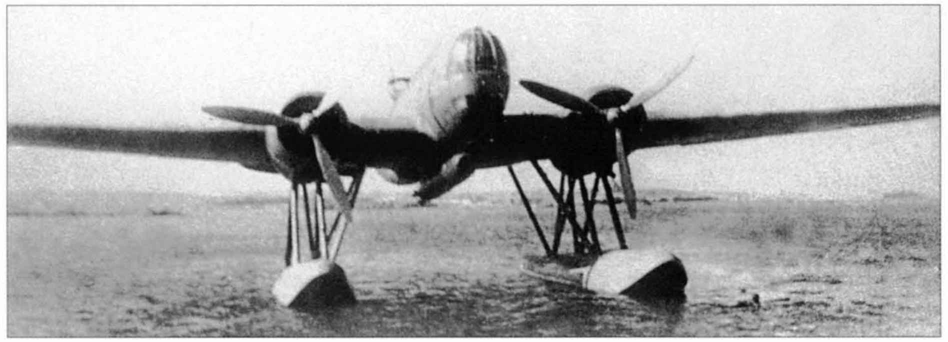
Three shots of the experimental DB-3TP (TsKB-51) torpedo-bomber floatplane.



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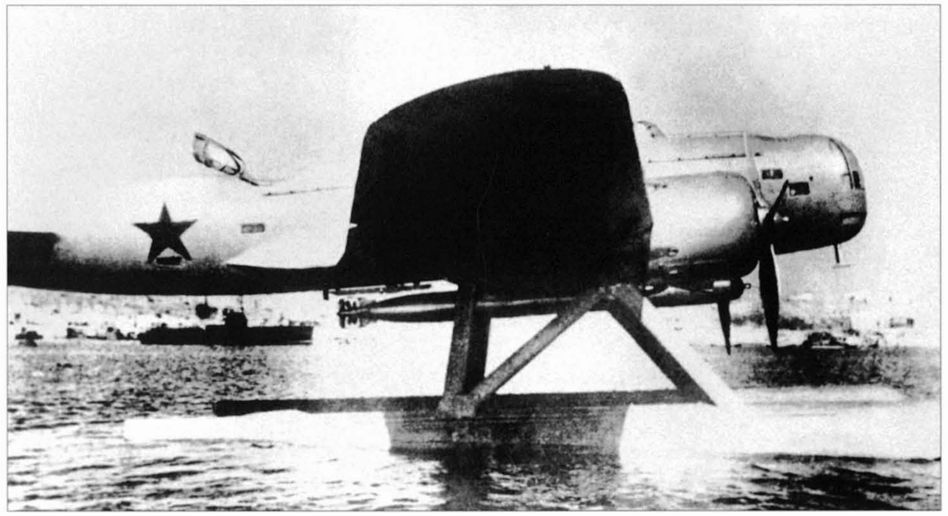
Above and below: The DB-3TP (alias DB-3PT) in waterborne condition. Note how the SU dorsal turret hinges open to serve as an exit.



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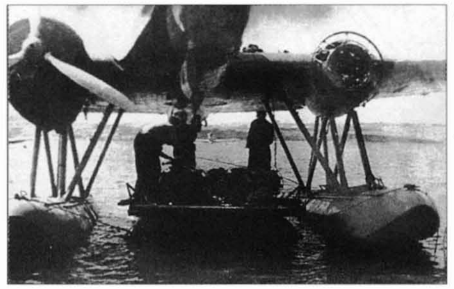

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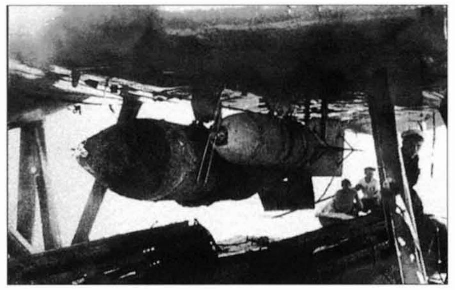

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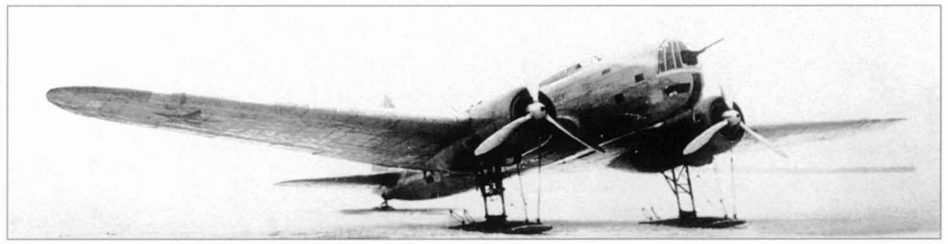
Above: Arming and servicing the DB-3TP was a tricky affair, necessitating the use of a special raft.

Above: An anti-shipping mine (left) and a 500-kg bomb under the fuselage of the DB-3TP.



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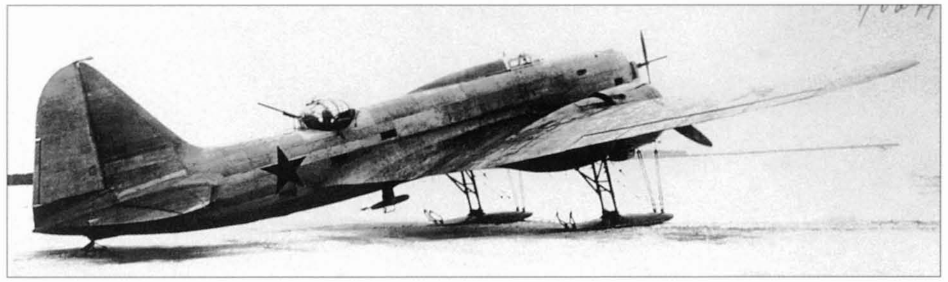

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Two views of the TSKB-54-I escort aircraft on skis. Note the ventral remote-controlled machine-gun.

and its climb rate and service ceiling were also reduced. Even so, the performance met official specifications and was better than that of the Beriyev MDR-5 and Chetverikov MDR-6 flying boats. The DB-3TP retained the basic type's good handling.

Test pilot Ivan Sukhomlin assessed the seaplane thus: 'The aircraft is well-produced as a torpedo-bomber and naval high speed bomber. It is fully suited to these roles.' Nevertheless, the DB-3TP was not put into series production owing to operational complications. It was very difficult to load bombs, attach torpedoes and service the engines while the aircraft was waterborne.

TsKB-54 escort aircraft prototypes

In 1938 an attempt was made to adapt the DB-3 to the role of an escort aircraft intended to defend bomber formations from attacks by enemy fighters (in the same way as the Boeing YB-40 was evolved from the B-17 Flying Fortress). Two machines were converted into this variant which was allocated the in-house designation TsKB-54. The first of these was based on the DB-3 2M-85 early production bomber and was regarded primarily as a testbed for the new, more potent armament. The latter comprised, like that of the bomber, a nose mounting and a dorsal turret, but these were fitted with 20-mm ShVAK cannon instead of machine-guns. The new aircraft retained the rear-firing ShKAS machine-gun mounted in a ventral hatch; it was supplemented by a second ShKAS mounted in a pivoting fairing on a short pylon under the fuselage. Its field of fire in the horizontal plane amounted to 240°. This remote-controlled and electrically actuated weapon was operated with the help of a periscopic sight. A fourth crew member was added to man the new installation.

The first TsKB-54 (also known as TsKB-54-I) was completed in early 1938. After a short period of factory flight testing it was turned over to NII VVS where it underwent testing between March and May of that year. The new armament complement received varying comments. The dorsal turret met with approval, while the nose mounting was found to be more difficult to use. As for the remote-controlled installation, it was deemed unacceptable. Rotation of this weapon had an adverse aerodynamic effect, causing excessive yaw and overswinging.

The second TsKB-54 (TsKB-54-II) built in 1939 was based on a more advanced production model, the DB-3 2M-87A. Its armament fit differed from that of the first machine. The ventral remote-controlled installation was deleted, giving way to two blisters with pivoted mounts for ShKAS machine-guns on the rear fuselage sides. The ventral hatch mounting was deleted, too. The nose-mounted and dorsal cannon installations were modernised and provided with new sights.

The aircraft passed manufacturer's tests and was submitted for State acceptance trials. Being 100 kg (220 lb) heavier than the baseline bomber, the escort machine proved to be 7-16 km/h (4.35-10 mph) slower than production DB-3s. This meant that the escort aircraft would be unable to keep pace with the bomber formations it was intended to protect. As a result, no series production of the TsKB-54 was undertaken.

DB-3 dive-bomber conversions

In 1938 several examples of the DB-3 2M-87B were experimentally adapted for the dive-bomber role. The modifications consisted of strengthening the fuselage, replacing the VISh-3 propellers with VISh-23 units to prevent overspeeding in a dive, and providing the navigator with a special dive-bombing sight. Tests were conducted in the Crimea in 1939. During the Soviet-Finnish 'Winter War' of 1939-1940 NII VVS formed a squadron of DB-3 dive-bombers which were used for attacks against small-size targets of importance. The bombers proved their worth fairly well, but it was clear that the type was not particularly suitable for dive-bombing, and a dedicated dive bomber had to be developed (eventually it emerged in the shape of the Petlyakov Pe-2).

DB-3K troop-carrier

The DB-3 was adapted for carrying small groups of armed personnel in a special streamlined cabin designed by Privalov. This cabin designated D-20 could be attached under the fuselage on bomb shackles in field conditions. It provided accommodation for ten troops with their sidearms. The aircraft was known as the DB-3K (for *kabina* – cabin).

Special systems were also developed for the external carriage of various items of military hardware, such as a 45-mm anti-tank gun, a 120-mm mortar, a motorcycle with a sidecar, paradroppable cargo containers and so on.

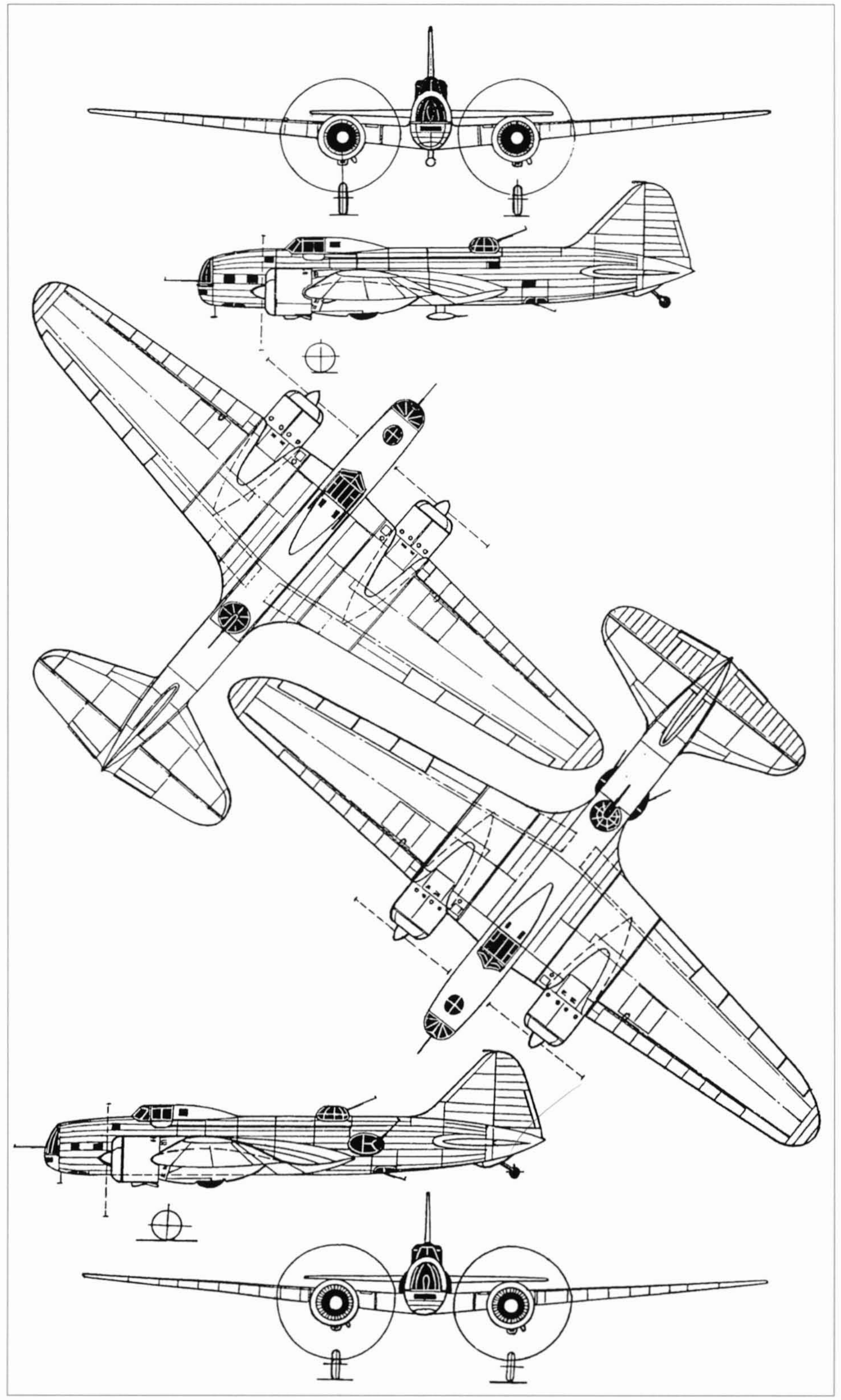
DB-3 glider tug

DB-3 bombers from different production batches were modified to tow heavy assault gliders. The aircraft were fitted with a towing cable lock and a system of 'concealed' navigation lights intended to provide orientation for the pilot of the towed glider at night.

DB-3 in experiments with remote-controlled aircraft

Between 1935 and 1941 experiments were carried out with several types of aircraft with a view to turning them into radio-controlled

Ivnamin Sultanov



Above: These three-views give a comparison of the TsKB-54-I (top) and the TsKB-54-II (bottom). Note the waist gun positions of the latter.

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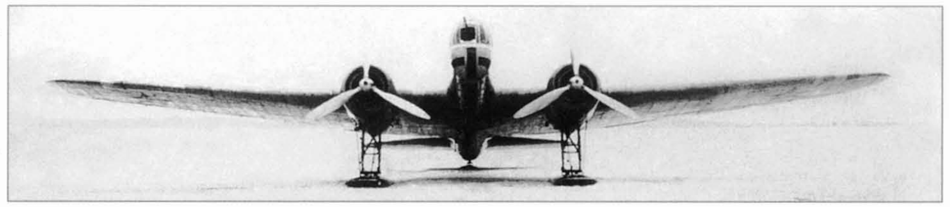

A front view of the TsKB-54-I.

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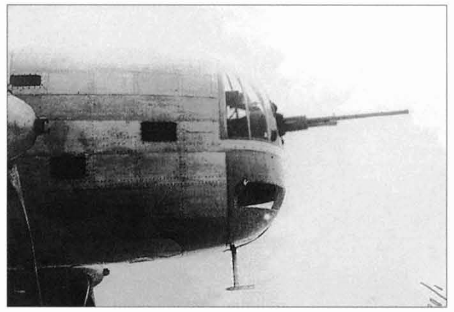

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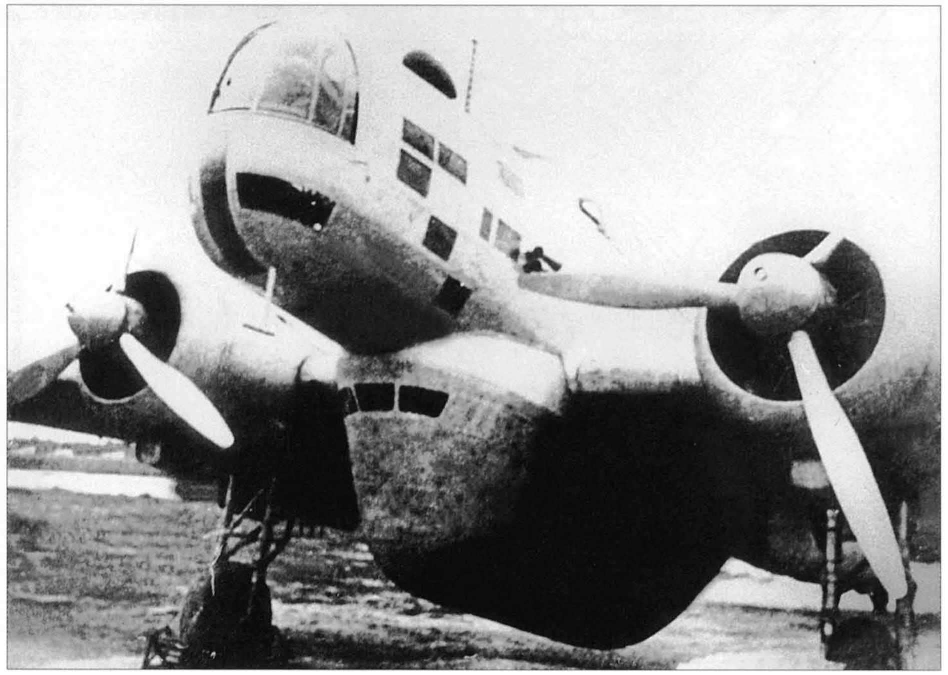
Detail views of the TsKB-54-I showing the 20-mm ShVAK cannon in the dorsal (MV-3) and nose turrets.



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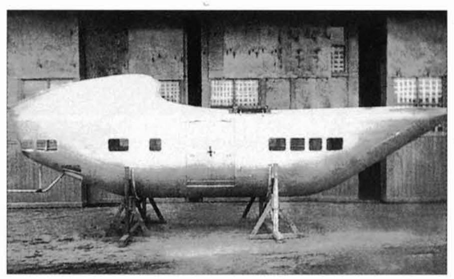
Above: The DB-3K was equipped with a troop cabin suspended under the fuselage. Note the faired DF loop aerial on top of the nose.



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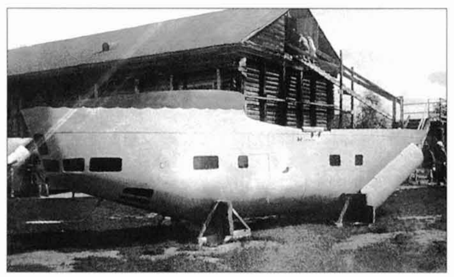

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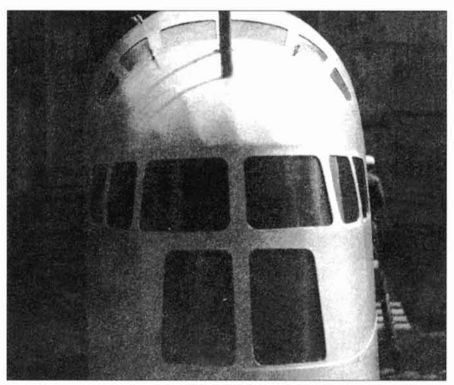
Above, left and right: At least three versions of troop cabins were developed for the DB-3K. The cabins illustrated here have both lateral and rear entry/exit hatches. Note how the top fits around the wing roots.



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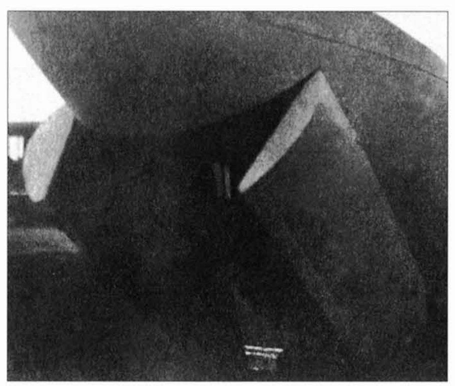

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Left: close-up of the glazing of one of the cabin versions; right: the rear hatch permitted paradropping, making the DB-3K suitable for inserting reconnaissance/sabotage groups far behind enemy lines.

flying bombs or remote-controlled reconnaissance aircraft and the like. These experiments involved TB-3, SB and DB-3 bombers. The latter were used primarily in the role of drone director aircraft for the pilotless TB-3 bombers (references to conversion of the DB-3 into flying bombs are rather vague).

DB-3 airliner and transport conversions

One of the first production DB-3s was converted into an airliner version designated '7-12'. It was fitted with six passenger seats installed in the navigator's station and in the former mid-ship gunner compartment.

In the late 1930s the Soviet Union supplied military aircraft to China, then at war with Japan. In 1938 two DB-3 bombers were modified at Plant No.39 to provide special passenger and cargo transportation services on the route used for ferrying Soviet aircraft to China. They could carry 11 passengers. This version was dubbed 'aircraft No.24'. A further two DB-3s were modified by the same plant for carrying fuel in extra tanks accommodated in the bomb bay. They were used on the same route.

There are also references to a 'courier' version of the DB-3 equipped with a passenger cabin which replaced the dorsal gunner's compartment. Several examples were converted from early-production DB-3s.

DB-3 – special-purpose variants (projects)

In 1939 the DB-3 came into consideration, along with the TB-3, as a prospective carrier aircraft for pilotless gliding torpedoes which were under development at that time. The projects in question were the PSN-2 and BPT gliding torpedoes developed jointly by the KB-21 design bureau and by the design bureau of Plant No.23 in Fili, then a western suburb of Moscow (now part of the city). The work on these and other similar projects was discontinued in July 1940.

In 1941 studies were made of a night interceptor version of the DB-3 intended for use in Moscow's anti-aircraft defence system. The project envisaged the installation of twin 20-mm ShVAK cannon in the nose and in the dorsal turret, while the ventral hatch position was to be fitted with twin UBT heavy machine-guns.

DB-3 – flying testbeds

Several examples of the DB-3 were used as flying testbeds for various experiments. One of these, sporting the tactical number 13 and the letters IE (in Cyrillic script) on the vertical tail, was used by TsAGI in 1940-1941 for studying the airflow around new airfoil sections in real flight. Mounted vertically above the fuselage were rectangular wing sections featuring different airfoils and different aspect ratio. Some sources cite LII (the Flight Research Institute) as the organisation that conducted the experiments (presumably in co-operation with TsAGI).

In 1942 a variant designated DB-3UPS (*oopravleniye pogranichnym sloyem*, boundary layer control) was used by LII for boundary layer control experiments. A production DB-3 2M-87B received modified wings with efficient high-lift devices (flaps and drooping ailerons) which was fitted with a BLC system. The boundary layer was sucked from the upper surface of the wings and high-lift devices through slits arranged spanwise; for this purpose a special power source (a 116-hp ZiS-101A automobile engine driving a suction fan) was mounted in the bomb bay.

An example of the DB-3 was used by LII for studying the behaviour of heavy aircraft in sideslip flight mode. The aircraft performed flights with a small braking parachute deployed from one of the outer wing panels.

Another DB-3 was used for flight-testing a powerful generator intended to serve as an onboard electric power supply unit.

DB-3F (IL-4) – a new basic version

In 1938, continuing their work on perfecting the DB-3, improving its technical features and performance and reducing the labour intensity of series production, the bureau's team of designers began to develop a new version, the DB-3F (manufacturer's designation TsKB-30F). In March 1942 the aircraft was renamed IL-4, acknowledging its chief designer. (This designation is sometimes used retrospectively with regard to all the DB-3F versions; in this account the authors have elected to retain the DB-3F designation for versions that had made their appearance before the designation change).

Specifications of DB-3 bombers (production versions)

Year	1937	1938	1940
Engine type	M-85	M-86	M-87B
Engine power, hp:			
at take-off	2 x 780	2 x 950	2 x 950
at rated altitude	2 x 800 (3,850 m/12,630 ft)	2 x 800 (3,850 m/12,630 ft)	2 x 900 (4,700 m/15,420 ft)
Wing area, m² (sq ft)	65.6 (706.2)	65.6 (706.2)	65.6 (706.2)
All-up weight, kg (lb):			
normal	6,802 (14,998)	6,600 (14,550)	8,000 (17,640)
maximum	n.a.	8,500 (18,740)	10,000 (22,050)
Maximum speed, km/h (mph):			
at sea level	311 (193)	331 (206)	330 (205)
at rated altitude	380 (236) (4,400 m / 14,436 ft)	395 (245) (4,000 m / 13,124 ft)	405 (252) (5,000 m / 16,400 ft)
Landing speed, km/h (mph)	113 (70)	113 (70)	121 (75)
Practical ceiling, m (ft)	8,400 (27,560)	8,300 (27,230)	9,000 (29,530)
Range, km (miles)	3,000 (1,865)	3,200 (1,989)	2,680 (1,665)
Bomb load, kg (lb)			
normal	n.a.	1,000 (2,205)	n.a.
maximum	n.a.	2,500 (5,512)	n.a.

The DB-3F had an extended forward fuselage with smoother lines, resulting in a better lift/drag ratio and considerably improving the navigator/bomb-aimer's working conditions. The most important changes concerned the airframe; mainly the wings, which were increased in area by 11 m² (118 sq ft) and made a little thinner, though the aerofoil section was unchanged. Alterations were also made to the fuel system and undercarriage. These major changes meant that almost the entire manufacturing process had to be altered. The DB-3 was designed in accordance with the manufacturing standards of the early 1930s, but by the end of the decade it was already impossible to build an aeroplane using the so-called 'cut-and-fit' method. Much labour consuming work was required, demanding the manipulation of multiple-component steel structures, the bending of sheet metal components and the welding of small joints. In the modified aircraft the wing spars were based on T-beams, and open double-sided riveting was widely used. As a result the quality of the airframe was improved. The fuel system was simplified by reducing the number of fuel tanks from ten to six. The fuel tanks were provided with an inert gas pressurisation system fed from a carbon dioxide bottle. The undercarriage retraction mechanisms were simplified and the shock absorber stroke was increased, improving taxying capabilities.

On 21st May 1939 test pilot Vladimir Kokkinaki performed the maiden flight of the DB-3F. Different sources interpret F either as *forseerovannyy* (uprated, referring to the engines) or as *fonar'* (canopy – a reference to the modified navigator's station). After it had successfully completed its production flight test programme, its State acceptance

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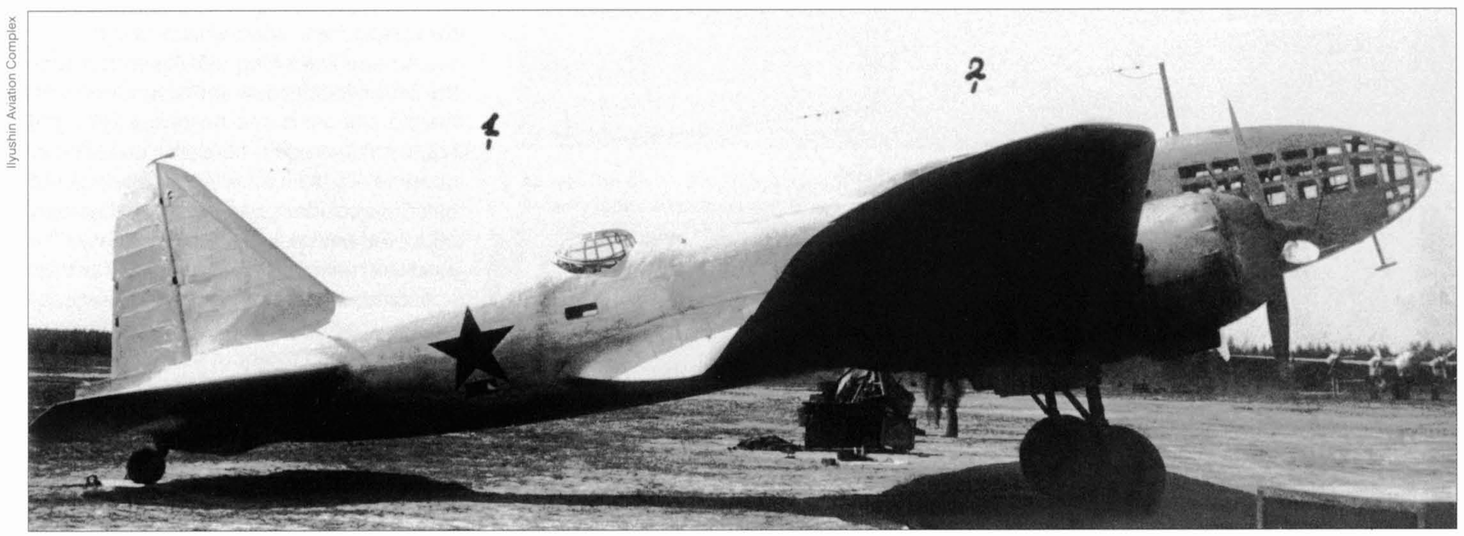
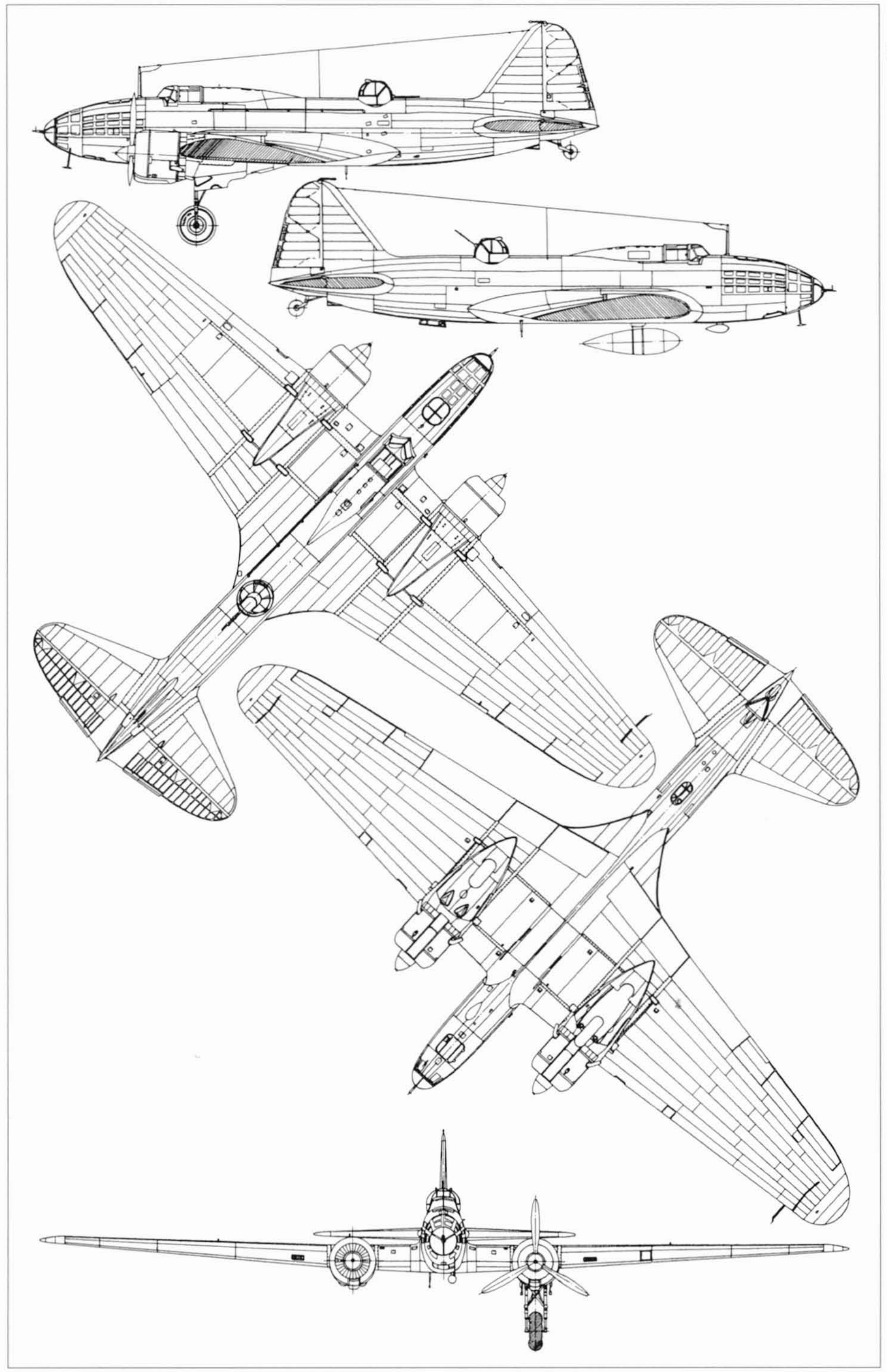
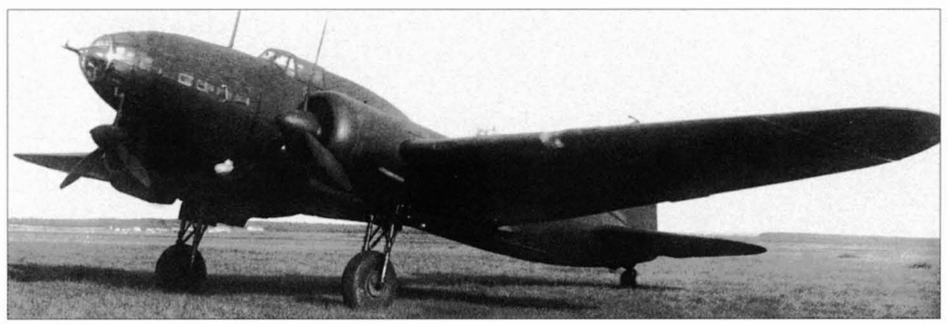


The prototype of the DB-3F (IL-4) was unpainted, except for the national insignia. Note the characteristically tapered cowlings of the M-87B engines with blister fairings on the engine over valve actuation gear.



Via Polygon Press

Above: Side, upper, lower and front views of a typical production IL-4.



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The initial production version of the DB-3F (IL-4) had M-88 engines with basically cylindrical cowlings and full-length carburettor air scoops.

tests started on 31st August the 1939. The DB-3F had a normal AUW of 7,660 kg (16,890 lb), including a 1,000-kg (2,205-lb) internal bomb load and full defensive armament. Powered by M-87B engines with a nominal power rating of 950 hp (708 kW), the experimental aircraft had a maximum speed of 445 km/h (276 mph) at 5,400 m (17,700 ft), and its maximum range at a total weight of 9,780 kg (21,560 lb) with a standard 1,000 kg (2,204 lb) bomb load was 3,500 km (2,174 miles). Take-off and landing performance was considerably improved. The glidepath was steeper, shock absorption was softer and braking was more effective, thus improving taxying. In the resulting report on the State acceptance tests it was noted that the DB-3F was considerably better than the DB-3 for bombing missions. The newly-developed canopy ensured excellent working conditions for the navigator, facilitating target location and defensive fire.

DB-3F 2M-88 production bomber

Production DB-3Fs were powered by the newly-developed Tumanskiy M-88 radials. The main feature of this engine was the use of a two-speed supercharger, which allowed it to attain 1,000 hp at 6,000 m (19,685 ft). The first flights of the new variant demonstrated that there was insufficient space inside the old cowlings for the new engines, and new cowlings with increased air inlet area were designed. However, the engines were not yet fully developed and had many defects, consequently suffering frequent failures. Their pistons constantly burned out and oil consumption was excessive, causing an abnormal amount of exhaust smoke. It was a long time before even the modernised M-88B was cleared of faults.

Some DB-3F bombers were fitted with M-87 engines of various sub-types; they were regarded as an interim version and were officially designated DB-3M, but this designation was often ignored.

An important step was taken to bolster the DB-3F's defensive armament. Instead of the old type SU dorsal turret and LU ventral hatch machine-gun mounting, newly-developed MV-3 'ball turret' and MV-2 ventral hatch mount designed by G Mozharovskiy and I Venevidov were installed. They had excellent manoeuvring properties in both the horizontal and vertical planes, ensuring rapid aiming. The new MV-3 installation reduced the aircraft's speed by about 15 km/h (9.3 mph), and the DB-3F now had a maximum speed of 343 km/h (213 mph) at sea level and 410 km/h (254 mph) at 6,600 m (21,650 ft). At an all-up weight of 8,000 kg (17,640 lb) it reached 5,000m (16,400 ft) in 13.6 minutes, and its service ceiling of 9,200 m (30,180 ft) could be reached in 40.5 minutes. In the

DB-3F's final test report the commander of NII VVS, General Filin, suggested that some of the earlier production aircraft might be rearmed with the new weapons.

The introduction of advanced working practices during series production proceeded with difficulty. In 1939-40 the total annual output of all factories was 1,000 aircraft, decreasing slightly in the first half of 1941. Even so, DB-3 and DB-3F bombers comprised 86% of the Soviet Long Range Aviation force on the eve of the war.

DB-3F 2M-88B production bomber

In late 1940 and 1941 production DB-3Fs started rolling off the line with the M-88B engines which became the basic engine type for this bomber. The M-88B retained the same power rating as the original M-88 but differed in having a number of detail changes designed to enhance its reliability (the low reliability of the M-88 engine had been the cause of numerous incidents with the DB-3F in operational service). At the same time the Ilyushin OKB studied various other engine options for the DB-3F in an effort to raise its speed to 485 km/h (301 mph) as prescribed by a government directive dated 31st May 1939. These options included the M-81 and M-89 engines.

DB-3F 2M-81 bomber prototype

A prototype DB-3F powered by Shvetsov M-81 radials first flew on 30th March 1940. These engines had a take-off rating of 1,500 hp and a nominal rating of 1,280 hp at 6,400 m (21,000 ft). Flight tests were disappointing: the engines failed to deliver the promised power output and were plagued by various faults making their operational use hazardous. All attempts to remedy these faults were to no avail, and eventually development of the M-81 was abandoned.

DB-3F 2M-89 bomber prototype

The installation of the new Tumanskiy M-89 engines on the DB-3F, which was undertaken in early 1941, held greater promise. This engine (a derivative of the M-88 radial) had a rating of 1,300 hp at 6,000 m (19,685 ft). However, it also had its fair share of teething troubles. Only a small number of these engines was manufactured before the outbreak of the war. The engine plant was evacuated and then switched to production of M-88B engines for the DB-3F.

DB-3FD (TsKB-30FD) limited production aircraft

In 1939 the Ilyushin OKB received an order for an M-88-powered version of the DB-3F with a wooden fuselage. It was designated DB-3FD (D – *derevyannyy*, wooden) and was known in-house as TsKB-30FD. The OKB produced a prototype and then a low-rate initial production batch consisting of five machines which were sent to service units for evaluation in the summer of 1941. In April 1942 this work was discontinued as being of secondary importance.

DB-3F 2M-105 bomber (project)

In the quest for alternative powerplants, in August 1941 Ilyushin came up with an idea of fitting Klimov M-105 liquid-cooled 12-cylinder Vee engines to the five DB-3Fs with wooden fuselages that had been built in early 1941. The work on this version proceeded for some time, but was discontinued in April 1942 because the authorities considered it to be of secondary importance.

DB-3F 2M-82 bomber prototype

This version is described below as the IL-4 2M-82.

DB-3F 2M-90 bomber prototype

According to some reports, a single DB-3F was equipped experimentally with M-90 engines in 1941 (there is some doubt about the veracity of this information). Attempts to use the M-90 engines on the IL-4 were made also in 1943 (see below).

DB-3FT (IL-4T) torpedo-bomber

The DB-3F bomber was adapted to the torpedo-bomber role in similar fashion to the DB-3T. Some documents quote the DB-3FT designation, but it was rarely used. When the DB-3F was redesignated IL-4, the torpedo-bomber version became the IL-4T.

Interestingly, in 1940 an order was placed (presumably by the Navy) for 20 DB-3Fs in a torpedo-bomber floatplane version similar to the DB-3TP (DB-3PT). However, the production plants involved refused to fulfil the order, citing with good reason the fact that no project or prototype of the floatplane version of the DB-3F had ever existed and that modifying the DB-3F to that configuration would entail too extensive structural redesign. Eventually the Navy consented to accept the DB-3F torpedo-bombers with a wheel undercarriage instead of floats.

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Above: Apart from a redesigned nose, the IL-4 was characterised by a more roomy cockpit canopy.

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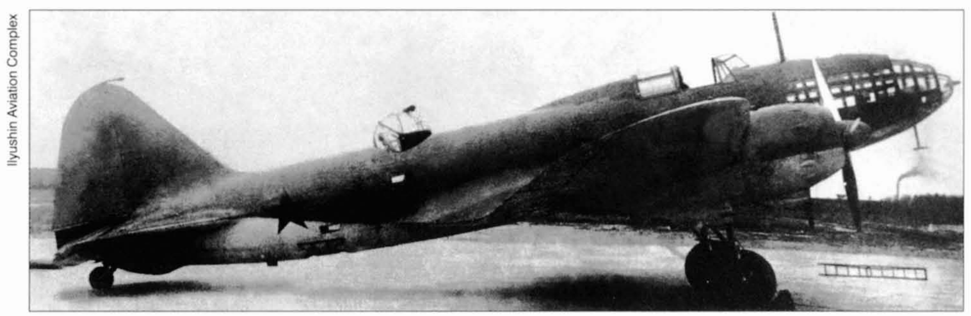
Above: The DB-3F 2M-81 prototype. The small diameter of the Shvetsov M-81 engines is evident; note the dorsally mounted carburettor air scoops.



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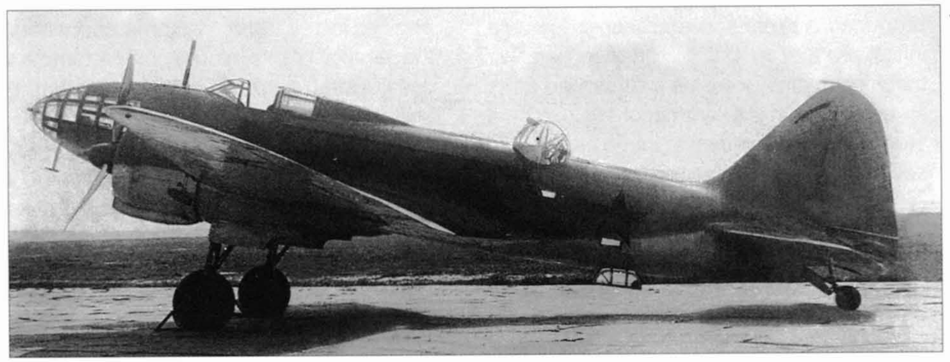
An IL-4 2M-87 (DB-3M) at NII VVS during State acceptance trials.



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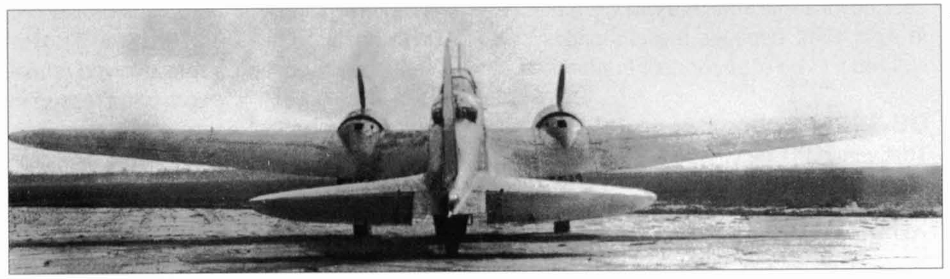
Above and below: An IL-4 2M-88 at NII VVS (note the characteristic hexagonal concrete slabs).



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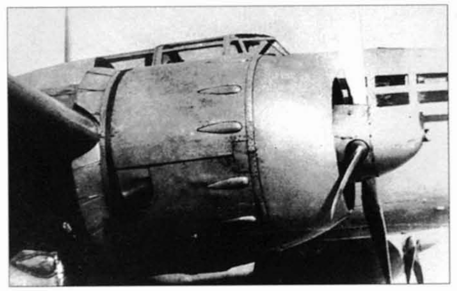
Above: The MV-3 dorsal turret of an IL-4.



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Above: The starboard engine of an IL-4 2M-87.

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An M-88-powered IL-4T torpedo-bomber runs up its engines before a winter sortie.

DB-3F as a dive bomber

In the summer of 1940 the DB-3F was tested in the dive bomber role. The aircraft proved capable of sustaining the G-loads at extremely steep dive angles, but it lacked the necessary aiming accuracy due to poor visibility from pilot's and navigator's cockpits. It was also hampered by the need to recover from a dive at the fairly high altitude of some 1,500 m (4,920 ft), which made the aircraft vulnerable to enemy anti-aircraft weapons.

DB-3F armed with large-calibre rocket projectiles

One DB-3F was fitted experimentally with two RS-203 rocket projectiles under the wings, the purpose being to investigate the feasibility and efficiency of the use of large-calibre rockets.

DB-3F with pressurised cabins (early projects – BOK-17 etc)

According to some reports, before the war attempts were made to fit pressurised cabins designed by Shcherbakov and Kashtanov to the DB-3F. Both rigid and bag-type cabins were considered. In 1940 N. N. Kashtanov was working in the KB-29 design bureau (a successor of the BOK design bureau) on the BOK-17 project of a high-altitude (stratospheric) bomber based on the DB-3. It featured a pressurised cabin forming an integral part of the aircraft's structure. The air for pressurisation was to be tapped from the engine superchargers. A mock-up review commission started its work in January 1940, but somewhat later the stratospheric bomber concept was abandoned and the work on the BOK-17 was terminated. Eventually, this line of development was revived, resulting in the emergence of the IL-4TK (see below).

DB-3F with strap-on cabins for troop transportation

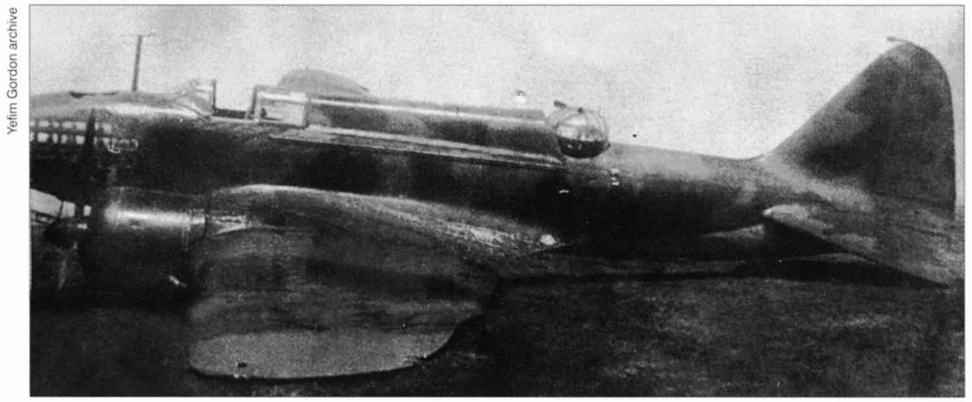
In 1941 the design bureau led by Aleksandr S. Moskalyov (known for his series of light aircraft) developed several types of strap-on cabins for the carriage of assault troops. Designated DK-10, DK-12 and DK-16 (DK = *de**sahnt**naya **kabin**a* – assault trooper cabin), they were intended for 10, 12 and 16 troopers respectively. The cabins were attached to the underside of the bomber's fuselage on bomb shackles. In this configuration the bombers were used primarily for delivering small groups of scouts for reconnaissance and sabotage in the enemy's rear.

DB-3F 'Paravan' (paravane)

The official designation of this one-off version is unknown and the above designation is styled on the designations of similar versions of other aircraft, such as the Tu-2 Paravan. Little is known about this DB-3F which was used in the winter of 1942-1943 in testing the efficiency of anti-aircraft barrage balloons. Initially, a specially-equipped SB (ANT-40) bomber was used in these experiments; it was fitted with a special cable run from one wingtip to the other via the end of a girder boom projecting ahead of the bomber's nose. Attached at the wingtips were structures simulating a wing section which was to be subjected to cutting by the barrage-balloon cable. A similar device was later mounted on the mentioned example of the DB-3F.

DB-3F director aircraft with remote-control equipment

During the course of experiments conducted between 1940 and 1941 a DB-3F, like the earlier versions of the DB-3, was equipped as a command aircraft for controlling TB-3 bombers converted into pilotless flying bombs. It remains unclear whether the DB-3F itself was converted into a flying bomb.



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Above: This DB-3F, which came to grief during a landing, represents a rare version with a deep spine fairing running all the way from the cockpit to the dorsal turret.

DB-3F with a dorsal spine fairing

To reduce drag, one of the pre-war versions of the DB-3F was fitted with a dorsal spine fairing extending from the pilot's cockpit to the dorsal turret. A production batch of so configured aircraft was manufactured.

IL-4 2M-88B production bomber

Most of the war-time production IL-4s, like their predecessors, the DB-3Fs, were fitted with M-88B engines which had the same power as the earlier M-88 but were more reliable for long range missions. The engines had a service life of some 150 hours.

IL-4 2M-88F production bomber

In 1943 a small number of IL-4s was fitted with the M-88F engines rated at 1,250 hp, as against the 1,100 hp of the M-88B. Greater power resulted in a considerably improved performance. However, the M-88F had a very limited production run.

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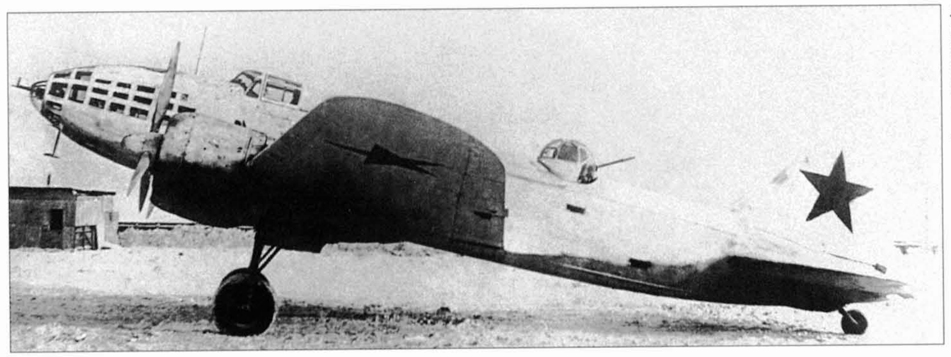
A line of factory-fresh IL-4s awaiting delivery at plant No.23. Note the construction number 3/18 (ie, third aircraft in Batch 18) chalked on the nose of the nearest aircraft; the second aircraft in the row is c/n 1/18 and the third one is c/n 1/17.



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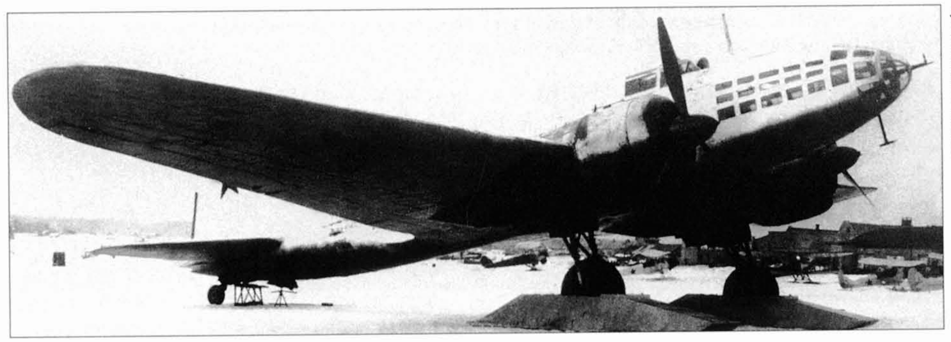
Above: An IL-4 2M-88 in winter camouflage.



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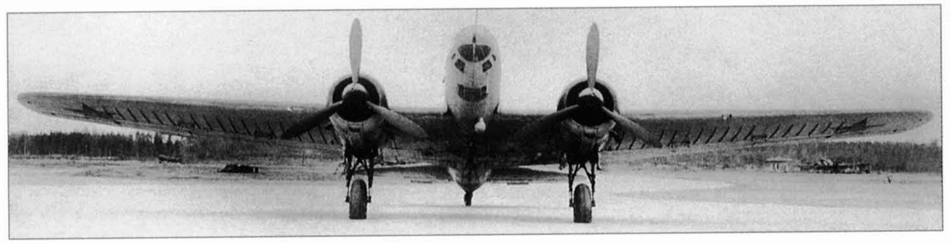
To facilitate winter operations with IL-4s, special 'slipper' skis were devised. The aircraft was rolled onto the skis, which then fell clear as the bomber became airborne.

IL-4 2M-82 (M-82NV) bomber prototype

A decision to adapt the IL-4 to the M-82 radials designed by Shvetsov was prompted by the reduction in the output of M-88 engines which was caused by evacuation of the Engine Plant No.29 and the difficulties of getting production under way at the new site. The first M-82-powered IL-4 (still bearing the DB-3F designation) was flown in February 1942 at Plant No.126 in Komsomol'sk-on-Amur. The more powerful M-82 (delivering 1,330 hp at a rated altitude instead of the M-88B's 1,100 hp) was expected to enable the bomber to attain a maximum speed of 470 km/h (292 mph); however, the gain in speed proved to be much smaller – the speed did not exceed 437 km/h (272 mph), and the range was reduced to 2,450 km (1,523 miles) owing to the M-82's higher fuel consumption. One more attempt to try out the M-82 powerplant on the IL-4 was made in 1943. The speed target was reduced to 450 km/h (280 mph), but the specification called for the installation of five machine-guns, including four 12.7-mm weapons. In the spring of 1943 an IL-4 powered by M-82NV engines with direct fuel injection was built at Plant No.23. It carried a heavy armament complement comprising five UBT machine guns (the usual three positions were supplemented by two beam machine-guns). The airframe incorporated many wooden elements and was overweight; in consequence, bigger wheels had to be fitted. The tests of this aircraft were not completed because of an engine failure and the unavailability of a spare engine. In the meantime, production of the M-88B engine at the new site got into full swing and further development of the M-82-powered version became pointless.



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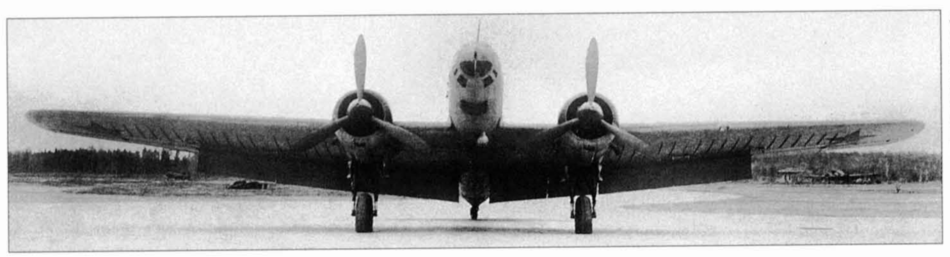

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These two photos of the IL-4 featuring new outer wings with increased leading-edge sweep accentuate the large flap area. Note the faired DF loop aerial under the nose.

IL-4 2M-90 bomber (project)

The M-90 engine (one more descendant of the M-85) with a take-off rating of 2,000 hp was among the engines considered for installation on the IL-4. An order issued by NKAP on 16th January 1943 required Ilyushin to install M-90 engines on an IL-4. One source states that in May and June 1943 a prototype of an IL-4 version powered by two M-90 engines was under construction at Plant No.23. There is no evidence as to whether this prototype was completed. According to an official report signed by Ilyushin, work on this project was discontinued in 1943.

Early in 1943 there were also plans for installing M-90 engines in the IL-6 – a radically redesigned derivative of the IL-4 (see below).

IL-4 2VK-105 bomber (project)

Some reports mention design studies of an IL-4 version powered by Klimov VK-105 (M-105) 12-cylinder Vee engines. It is not clear whether this is an independent project or just a different name for the projected M-105-powered DB-3F (see above).

IL-4 2ACh-30B bomber (project)

The Ilyushin OKB studied the possibility of equipping the IL-4 with Charomskiy M-30B (ACh-30B) diesel engines. This project was put into effect only on the IL-6 derivative (see below).

IL-4 with US engines (projects)

Studies were made for equipping the IL-4 with US-manufactured radial engines. The engines that came into consideration were the Wright R-2600, the Pratt & Whitney Double Wasp and the Pratt & Whitney R-1830-33. Calculations showed that installation of the R-2600 and the Double Wasp would lead to a considerable reduction of range, compensated to some extent by improvement of other performance characteristics in the case of the R-2600. As for the R-1830-33, its introduction might increase the range by some 300 km (186 miles), but it involved the use of turbosuperchargers which were not yet fully mastered and might become a source of trouble, reducing the aircraft's reliability. Ilyushin was extremely sceptical about using these engines, sticking to the opinion that the M-88 remained the best option. Suggestions that the R-1830-33 engine be installed on the IL-4 for operational testing were not followed up.

IL-4 with wooden airframe elements

From the early autumn of 1941 onwards a wooden navigator's station, cockpit floor and tail fairing were installed on production aircraft owing to a shortage of duralumin.

IL-4 with increased wing leading edge sweepback

Wartime experience showed that a dorsal gunner alone could not ensure adequate protection against air attacks from the rear. One more gunner was added to man the ventral machine-gun. The fourth crew member and the armour protection for the gunner considerably displaced the aeroplane's CG, upsetting the longitudinal static stability and controllability. This was rectified in the machines built from the summer of 1942 onwards; they received newly-developed outer wing panels with slightly increased leading-edge sweepback which moved the CG forward relative to the mean aerodynamic chord.

The redesigned outer wing panels had a new airfoil section which increased the thickness/chord ratio by 10%, and featured a composite structure combining metal spars with wooden ribs and skin. The thicker airfoil section of the detachable outer wings and the displacement of the lower rib caps outside the skin (the ribs were clearly visible on the undersurface) permitted the installation inside the outer wing panels of three self-sealing fuel tanks instead of one, increasing the total fuel load by 1,135 kg (2,500 lb) compared with the production DB-3F. The aircraft's all-up weight also increased, being 26,741 lb (12,130 kg) in overload configuration, but the performance was sufficiently high. At a normal AUW of 10,055 kg (22,170 lb) the maximum speed was 404 km/h (251 mph) at 6,650 m (21,820 ft). Because of the high fuel capacity, range increased considerably. With a normal internal bomb load of 1,000 kg (2,205 lb) the aircraft had a range of 3,585 km (2,227 miles) at 340 km/h (211 mph), and this could be increased to 4,265 km (2,650 miles) if the speed was reduced to 250 km/h (155 mph). A 2 m^2 (21.5 sq ft) increase in flap area meant that the aircraft was still able to operate from tactical airfields despite the considerable increase in weight. The newly-developed AV-5F-158 propellers of greater diameter also contributed to this ability.

Thanks to the new wing aerodynamics, controllability and manoeuvrability were greatly improved. According to pilot assessments, handling with the new wing seemed to be easier.

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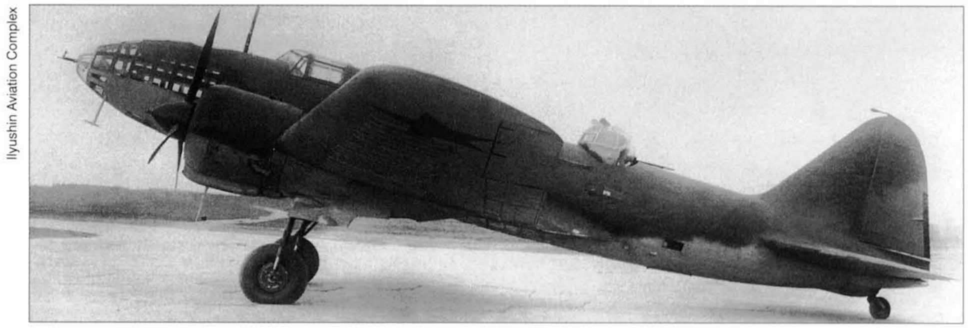

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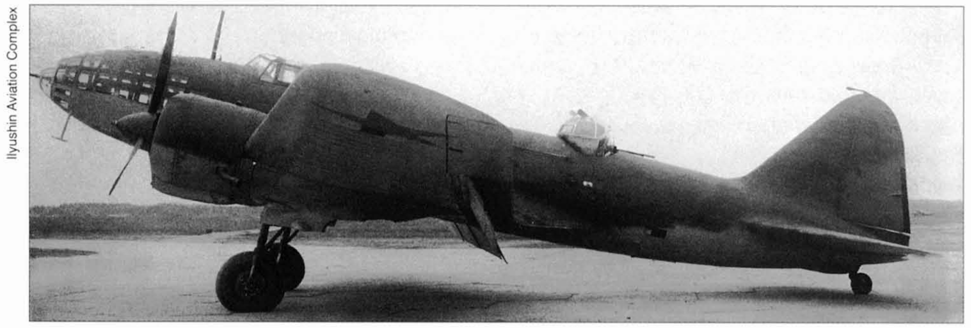

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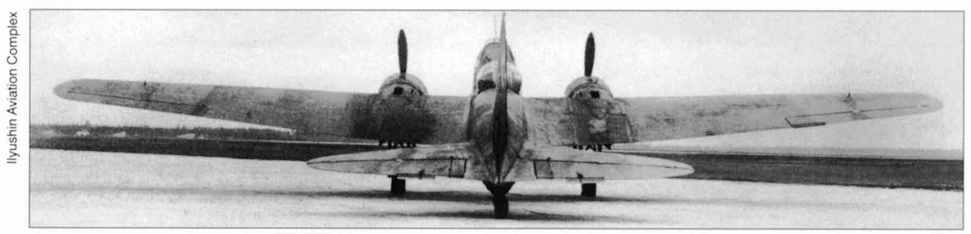

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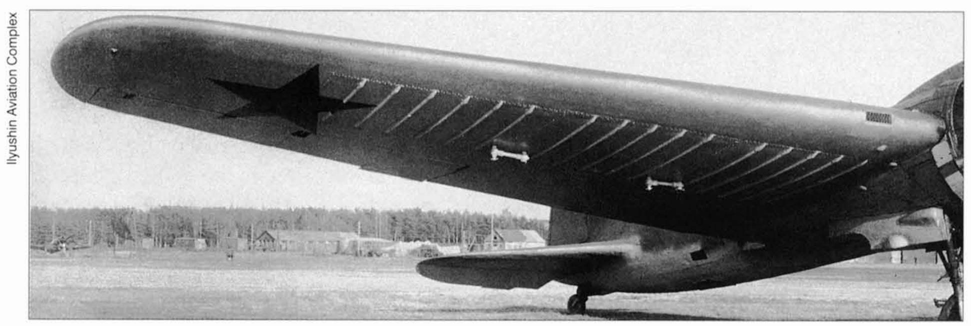

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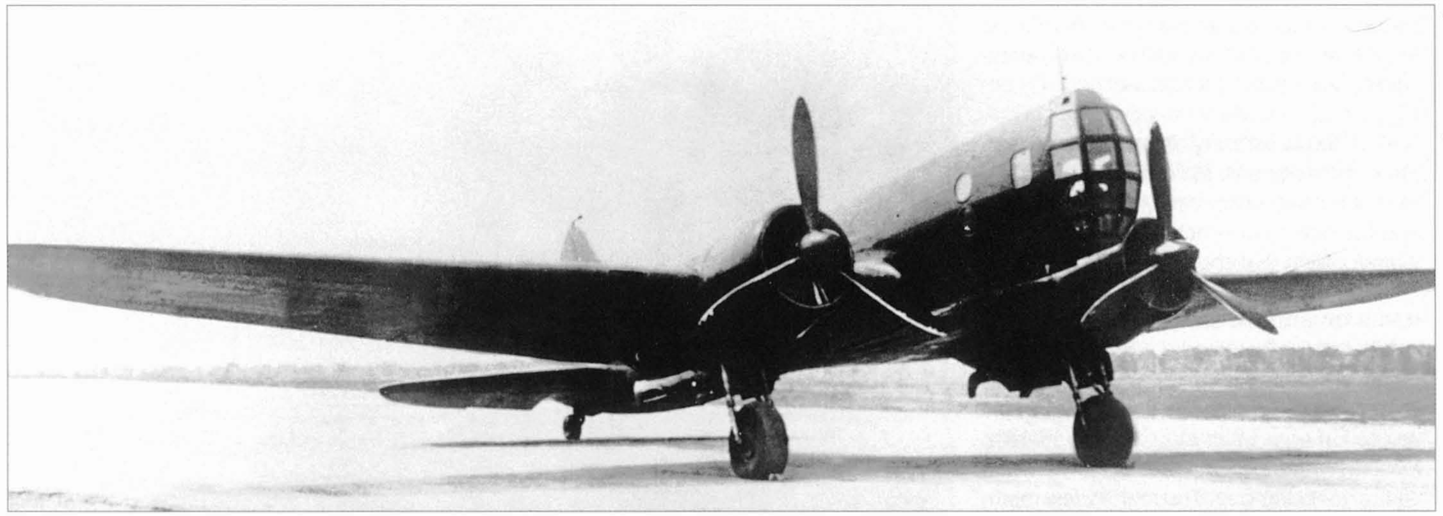
Six more photos of the rewinged IL-4 featuring increased leading-edge sweep. Note the rib caps protruding through the wing undersurface and the twin hardpoints under the outer wings.



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Above: The IL-4TK experimental high-altitude aircraft featured an altogether different front end, the full-height faceted glazing of the pressure cabin evoking associations both with the Bolkhovitinov DB-A and with some German bombers. The aircraft appears to be painted black overall.

In 1943 several production plants resorted to increasing the sweepback of the detachable outer wings by the simple expedient of turning them to the sides around the rear (trailing edge) joining point. A 6° wedge was inserted between the mating rib surfaces of the wing centre section and the outer wing panel. This was accompanied by lengthening the spars and redesigning the attachment fittings.

DB-3Fs featuring the structural changes described above were in action until the war's end. The new-type outer wing panels with increased sweepback were eventually manufactured also in an all-metal version.

IL-4 – armament versions

Wartime experience showed the number and calibre of defensive weapons of the IL-4 to be inadequate. In some VVS bomber regiments the IL-4s had their defensive weaponry bolstered by the installation of heavy machine-guns in the ventral hatch. In May-June 1942 production aircraft began receiving an updated UTK-1 turret designed by I Shebanov and mounting a 12.7-mm UBT machine gun instead of the MV-3 turret. The gunners' compartments were equipped with armoured shields. As mentioned above, a fourth crew member was added to operate the ventral machine-gun. To retain the range, the normal AUW of the four-seat version of the IL-4 was increased to 9,470 kg (20,880 lb), and the fuel capacity was increased by 525 kg (1,157 lb) by the use of two external tanks suspended on bomb racks. The maximum speed decreased at all altitudes by 5-10 km/h (3.1-6.2 mph), the rate of climb dropped by 40% and the service ceiling by 1,100 m (3,600 ft); all of these figures were compared with the prototype built in 1940. This performance was regarded as satisfactory for night flights; moreover, the aircraft's range according to the tests proved to be 3,800 km (2,361 miles). However, this figure corresponds not to the cruising speed of the DB-3F but to economical speed.

From July 1942 the bomber's armament was supplemented by the AG-2 aviation grenades for protection from the rear. In 1943 an idea cropped up of using the IL-4 also as a day bomber. For this purpose a special armament version was studied; it comprised, in addition to the usual complement, two machine-guns in beam positions.

The offensive armament of the IL-4 was sometimes supplemented by rocket projectiles. From 1942 onwards, bombers of this type serving with the Black Sea Fleet units were equipped with guide rails for RS-82, RS-132 or M-13 rocket projectiles. The guide rails were mounted under the wings and, sometimes, under the navigator's station.

IL-4TK (IL-4K) high-altitude bomber and reconnaissance aircraft

In 1943 the Ilyushin OKB produced a high-altitude version of the IL-4 fitted with a pressurised cabin. Designated IL-4TK (also known as IL-4K, according to some sources), this was a prototype high-altitude bomber and reconnaissance aircraft. The powerplant comprised two M-88B engines equipped with TK-3 turbosuperchargers; the latter enabled the aircraft to reach high altitudes by raising the engine output at a calculated 11,000 m (36,090 ft) to nearly 880 hp, twice the figure available without turbosuperchargers. The aircraft had no defensive armament. It was equipped with the AFA-3 aerial camera remote-controlled by navigator. Two crew, pilot and navigator, were accommodated in a pressurised cabin; the air was fed into the cabin from the superchargers. The cabin blended into the forward fuselage contours with its hemispherical glazed nose section. With the pilot's cockpit deleted from the top of the fuselage, the aircraft looked markedly different from the standard bomber.

Testing of the IL-4TK was conducted in the period between 10th March and 29th May 1943. In the course of five flights performed in April 1943 the IL-4TK attained an altitude of 9,300 m (30,510 ft) which fell short of expectations. This was traced to imperfect functioning of the TK-3 superchargers. Test pilots also complained about the restricted view caused by the insufficient glazing area, and the poor climb rate. These deficiencies were to be remedied on a modified version which was to feature improved TK-M turbosuperchargers, new AV-9F high-altitude propellers and a revised pressurised cabin. In addition to increased glazing area, it was to be fitted with a remote-controlled gun barbette in a chin installation. According to some reports, the IL-4TK so configured entered tests on 10th August 1943; they were confounded by malfunctioning of propellers. This problem was eventually cured by 10th November 1943, but Ilyushin took the decision to discontinue the work on this project in favour of the more urgent work on the AM-42-powered IL-2 derivatives. The IL-4TK was not proceeded with, because strategic ascendancy gained by Soviet aviation from 1943 onwards enabled the standard IL-4s escorted by fighters to fulfil their tasks, and further work on the high-altitude version lost its importance. Yet, the experience thus gained proved to be an asset at a later stage of the OKB's work.

IL-4 2M-88B with TK-3s/without pressurised cabin

This high-altitude bomber was built in a single example with the same powerplant as the IL-4TK, but without the pressure cabin. It was intended for testing the powerplant and the turbosuperchargers of the IL-4TK and preceded the latter, entering flight test in December 1942. The testing revealed the same problems with the inadequate output of the TK-3 superchargers as those encountered on the IL-4TK and prompted a speedier introduction of the more potent TK-M superchargers, but the work, as related above, was terminated at an early stage.

IL-4 glider tug

Like its predecessor, the DB-3, the IL-4 was used for towing heavy assault gliders, such as the Antonov A-7, Antonov/Moskalyov AM-14, Gribovskiy G-11 and G-29. The IL-4s were modified for the purpose in a fashion similar to the DB-3 glider tugs (see above). A well-trained IL-4 pilot could tow two or three A-7 gliders simultaneously.

IL-4 equipped for external cargo carriage

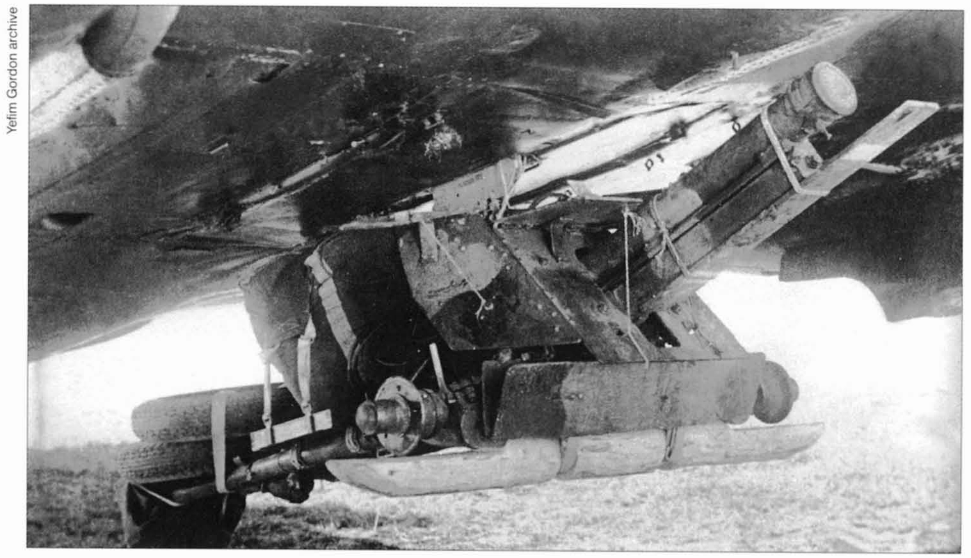
In 1943-44 the IL-4 aircraft were widely used as transports for delivering supplies to the Soviet partisans fighting against German troops on the occupied territories. External stores that could be carried by the IL-4s included 45-mm (1.77-in) guns (in streamlined containers), 82-mm (3.22-in) and 120-mm (4.72-in) mortars, small cargoes and ammunition in bag-type packages and paradroppable cargo containers.

IL-4 with a towed 'flying fuel tank'

In 1942 a rather unorthodox method of increasing the IL-4's range was suggested. It consisted of providing the bomber with a 'flying fuel tank' – a specially modified A-7 glider towed behind the bomber. The tanks housed in the glider contained 1,000 litres (220 Imp gal) of fuel. The fuel was transferred from the glider to the bomber with the help of an electrically driven pump via a hose attached to the towing cable. In the winter of 1942-43 this system was successfully flight-tested. However, this method was not used operationally, presumably because the towed glider would severely restrict the bomber's freedom of manoeuvre and reduce its speed. Besides, the A-7 gliders were in short supply.

IL-4 fuel transporter

In addition to their primary bomber role, the IL-4s were used as aerial fuel transporters to cater for the needs of Fighter Air Units which were constantly redeployed to new unprepared field airstrips to keep pace with the rapidly advancing ground forces. In one of such operations nine IL-4s, performing three day-time missions, transported in their tanks 54 tonnes (119,050 lb) of fuel to a tactical airfield used by a fighter air unit. This amount was sufficient for 108 fighter sorties.



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Above: A 45-mm anti-tank gun suspended under the fuselage of an IL-4. The detached wheels are strapped to the outriggers.

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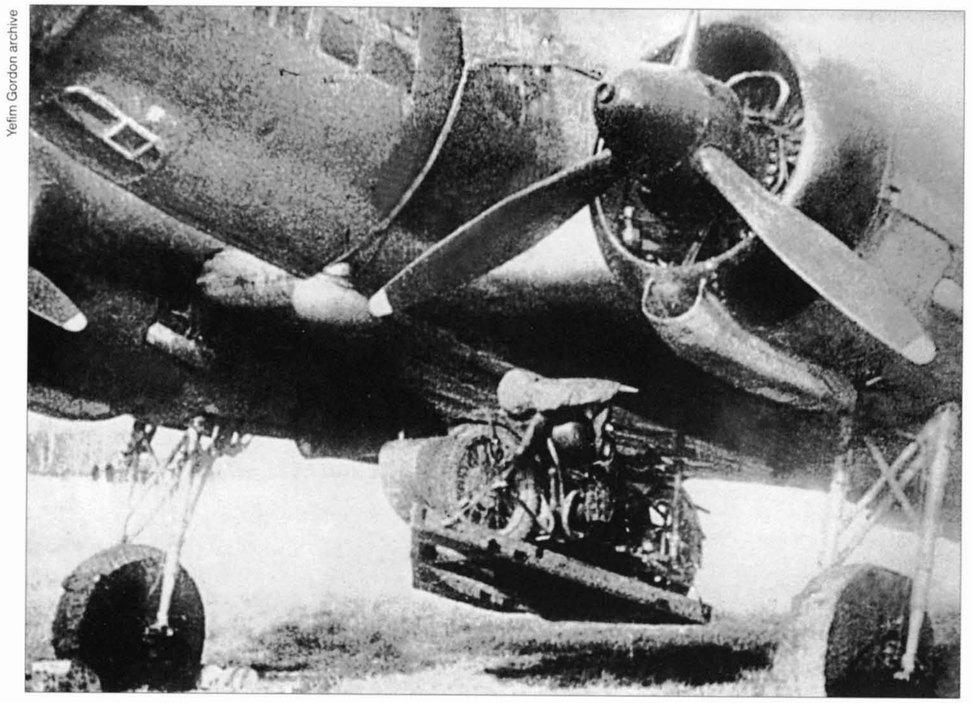
Above: An IL-4 with a light gun in a streamlined container under the fuselage. Interestingly, in this case the gun's wheels remain in place.



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A K-72 motorcycle with sidecar suspended under the fuselage of an IL-4 2M-88 on a cargo platform.

Specifications of the DB-3F/IL-4 bombers (production versions)

Type	DB-3F	DB-3F	IL-4
Year	1940	1941	1942
Crew	3	4	4
Engine type	M-88	M-88B	M-88B
Engine power at take-off, hp	2 x 1,100	2 x 1,100	2 x 1,100
Wing area, m² (sq ft)	66.7 (718)	66.7 (718)	67 (721)
All-up weight, kg (lb):			
normal	8,033 (17,710)	9,470 (20,880)	10,055 (22,170)
maximum	10,153 (22,390)	11,570 (25,510)	12,120 (26,725)
Maximum speed, km/h (mph):			
at sea level	350 (218)	345 (214)	332 (206)
at rated altitude	435 (270) (6,800 m/22,310 ft)	422 (262) (6,800 m/22,310 ft)	398 (247) (6,000 m/19,680 ft)
Range, km (miles)	3,300 (2,050)	3,800 (2,360)	3,585 (2,230)
with a bomb load, kg (lb)	1,000 (2,205)	1,000 (2,205)	1,000 (2,205)
Practical ceiling, m (ft)	10,000 (32,800)	8,900 (29,200)	8,300 (27,230)
Take-off run, m (ft)	400 (1,310)	480 (1,575)	530 (1,740)
Landing run, m (ft)	500 (1,640)	500 (1,640)	575 (1,886)
Bomb load, kg (lb):			
normal	1,000 (2,205)	1,000 (2,205)	1,000 (2,205)
maximum	2,500 (5,512)	2,500 (5,512)	2,500 (5,512)

IL-4 reconnaissance aircraft

In a reconnaissance version (bearing no special designation) the IL-4 was equipped with aerial cameras for vertical and oblique photography. Endurance, with drop tanks, was 7 to 9 hours. A bomb load was carried if needed.

IL-4 aerial photography aircraft

In 1946 several examples of the IL-4 were converted into a civil aerial photography (survey) version to cater for the needs of the Ministry of Geology.

IL-4 with a radar

In 1944 an IL-4 was fitted experimentally with the Gneis-2M radar intended for detecting surface vessels. Another IL-4 was used for experiments with the SCh-3 identification friend-or-foe (IFF) transponder in the period immediately after the end of the war.

IL-4 military transport version (project)

Design studies were made of a military transport derivative of the IL-4 during the closing stages of the war.

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A DB-3M (DB-3 2M-87B) with a paradroppable cargo container under the fuselage.

DB-3 and IL-4 in action

The DB-3 received its baptism of fire in China in 1939 when the Soviet government came to the aid of China in her struggle against the Japanese invasion. In the summer of 1939 two groups of DB-3 bombers, each comprising 12 machines, were flown from the Soviet Union to one of Chinese airfields. The groups were headed by Captain G. A. Kulishenko and Captain N. A. Kozlov. After an initial period of preparations the Soviet airmen undertook a series of successful bombing raids against targets in the rear of the Japanese army; one of these was the Japanese air base in Han Kuo. Later the DB-3 bombers were flown by Chinese pilots as well.

Another military conflict in which the DB-3 saw action was the Soviet-Finnish 'Winter War' of 1939-1940. Operating under harsh winter conditions, the bomber crews flew sorties against various kinds of targets, acquiring useful experience. Both the strengths and weaknesses of the bomber came to the fore, providing the basis for a further improvement of the design.

The German invasion into the Soviet Union in June 1941 marked the beginning of the most important chapter in the service career of the DB-3/IL-4 bomber. The Ilyushin bombers had suffered no losses on the ground on the first day of the war because the Luftwaffe made no raids on airfields in the Soviet rear. On the morning of 22nd June 1941 VVS Commander-in-Chief of the Red Army General Pavel F. Zhigarev tasked the 3rd Bomber Air Corps with annihilating the enemy troops in the region of the Suvalki salient. The first bombers to take off belonged to the 207th BAP (*bombardirovochnyy aviapolk* – Bomber Regiment), led by the unit's commander, Lt. Col. G. Titov. On the next day the DB-3s were to attack Königsberg, Danzig and Warsaw.

Subsequently the long-range bomber arm's main forces were used against the enemy's motorised infantry which had penetrated the front line. The DB-3s fought hard, but suffered heavy losses. For example, on 26th June 1941 43 DB-3F crews failed to return from their missions, mainly owing to bad planning and organisation of the raid. The bombers had no escort fighters at all, and were therefore obliged to fly at low altitudes, where the anti-aircraft fire was intense. The German command acknowledged that the DB-3 was almost as fast as the SB but was harder to shoot down. The pilot was protected by an armoured backrest and the fuel tanks were similarly protected, and the aircraft had a more robust structure and was more resistant to battle damage. Attention was also drawn to the fact that all of the bombers had ventral

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Above: A fine air-to-air study of an IL-4 2M-88. Note the flame dampers on the exhaust pipes in keeping with the aircraft's principal night bomber role.

machine guns and could carry a crew of four. The additional gunner increased the DB-3's defences.

An important task assigned to the DB-3 was the bombing of Berlin. The newspaper *Pravda* reported at the time: '*On the night of 7th/8th August a group of our bombers performed a reconnaissance flight over German territory and dropped incendiary and high explosive bombs on military objectives near Berlin. As a result of the bombing, some fires were started and explosions were seen. All of our bombers returned safely.*'

It later transpired that the air raid was performed by DB-3Ts of the 1st Minelayer/Torpedo-Bomber Regiment of the Baltic Fleet Air Arm under Colonel Ye. Preobrazhensky. Starting in August, 12 DB-3Fs of a long range aviation group commanded by Major V. Schelkunov began flying missions to Berlin. An attempt was made to increase the bomb load (the total bomb load during the first flights was 800 kg/1,760 lb) by suspending two FAB-500 or FAB-1000 bombs externally, but the short runway of the grass airfield in Kogul and the aeroplanes' worn-out engines resulted in disaster. All subsequent flights were made with the standard 800-kg (1,760-lb) load. On 12th August 1941 the enemy detected the Soviet airfields and started bombing them. In addition, instruction No.34 issued by Hitler on the same day proclaimed, in particular: *'As far as conditions allow, our aircraft must annihilate the military air bases on Dago and Esel Islands. It is very important to destroy these airfields, which enable air raids to be made on Berlin.'*

That order demonstrated once again the great psychological importance attached to the DB-3 and DB-3F missions. By that time Long-Range Aviation crews had started flying at night, at high altitudes. Between 10th July and 30th September 1941 DB-3Fs flown by Baltic Fleet and Black Sea Fleet crews delivered strikes against objectives in Königsberg, Danzig, Helsinki, Warsaw and Konstanta, among other targets. As a direct result of the 4th Bomber Air Corps' attacks, the output of Romania's oil industry decreased by 30%.

DB-3 regiments were used in combat missions against Nazi troops during the offensive against Moscow, performing mostly tactical tasks. Crews of the 751st BAP (forming part of the 1st Heavy Bomber Air Division) distinguished themselves considerably, and the regiment was soon promoted to the 8th GvBAP (Guards Bomber Air Regiment). Their DB-3Fs bombed the enemy in the regions of Maloyaroslavets, Rzhev, Vyaz'ma and Yartsevo.

By 22nd October 1941 there were 439 bombers in Soviet long-range bomber units, of which 310 were DB-3s. By 15th December 1941 the figures had fallen to 273 and 182 respectively. The regiments continued to score successes, attacking enemy troop concentrations on roads and at railway junctions. As a result of a government resolution issued on 5th March 1942 the DB-3 regiments were reorganised. The units and regiments of long-range bombers were reformed into the Long-Range Aviation (ADD – *Aviahtsiya **dahl'**nevo **dey**stviya*) under the command of General Aleksandr

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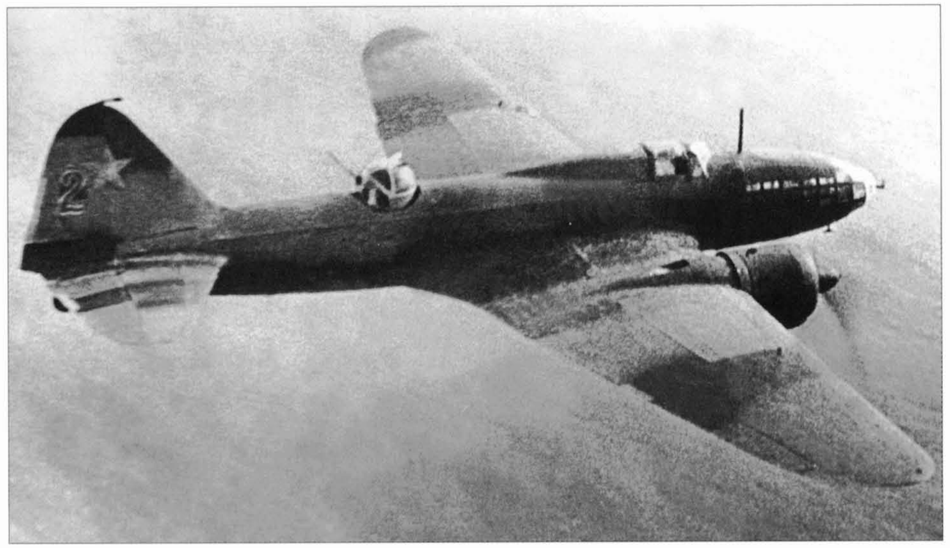
The crew of an IL-4T configured with an anti-shipping mine receives a mission briefing. Note that the airmen are wearing bright-coloured life jackets.



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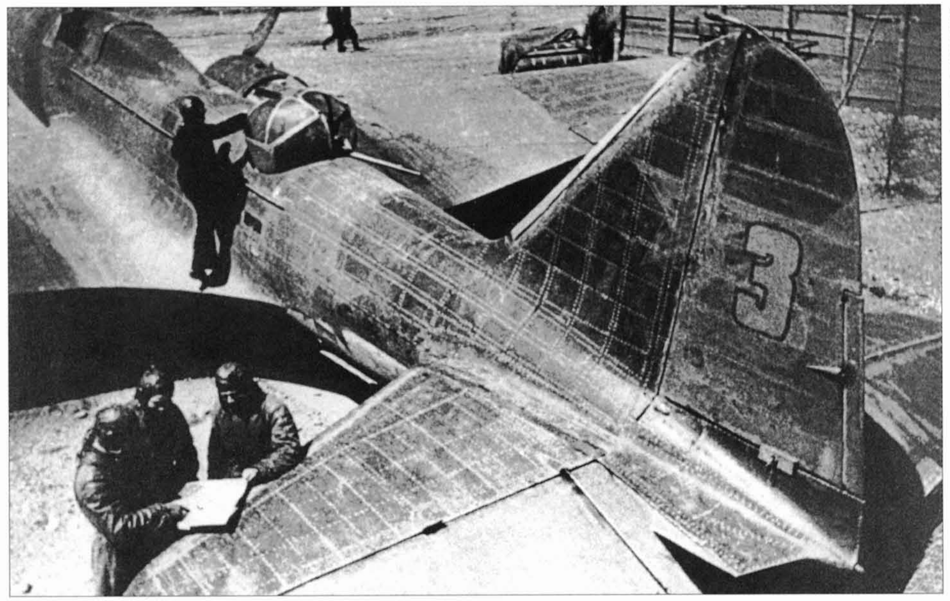
Above: An IL-4 2M-88 with the tail number '2 Blue' (probably a Naval Air Arm aircraft) cruises over the sea. Note the oil cooler air outlet at the top of the engine nacelle.



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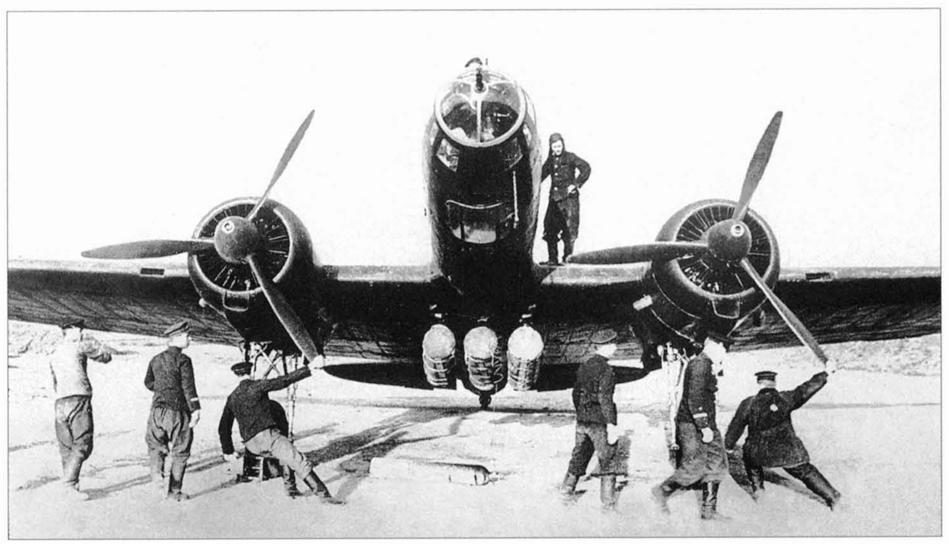
Above: Three of an IL-4's four crew members pore over a map of the target area while the dorsal gunner closes the hatch of the turret. Note that the star insignia have weathered away to almost nothing.



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When starter trucks were not available, the engines had to be started manually. Here the ground crew prepares to give the propellers of an IL-4 (carrying three paradroppable cargo bags) the old heave-ho; note the compressed air bottle used for engine starting.

Ye. Golovanov. The ADD was placed outside the framework of the Air Force and subordinated directly to the country's Supreme Command. This made it possible to concentrate the use of long-range bomber units on the most important sections of the front. By June 1942 the ADD comprised 27 Air Regiments grouped into ten Air Divisions. By the end of that year the number of long-range bombers on strength rose from 350 to 1,000. These were mainly IL-4s.

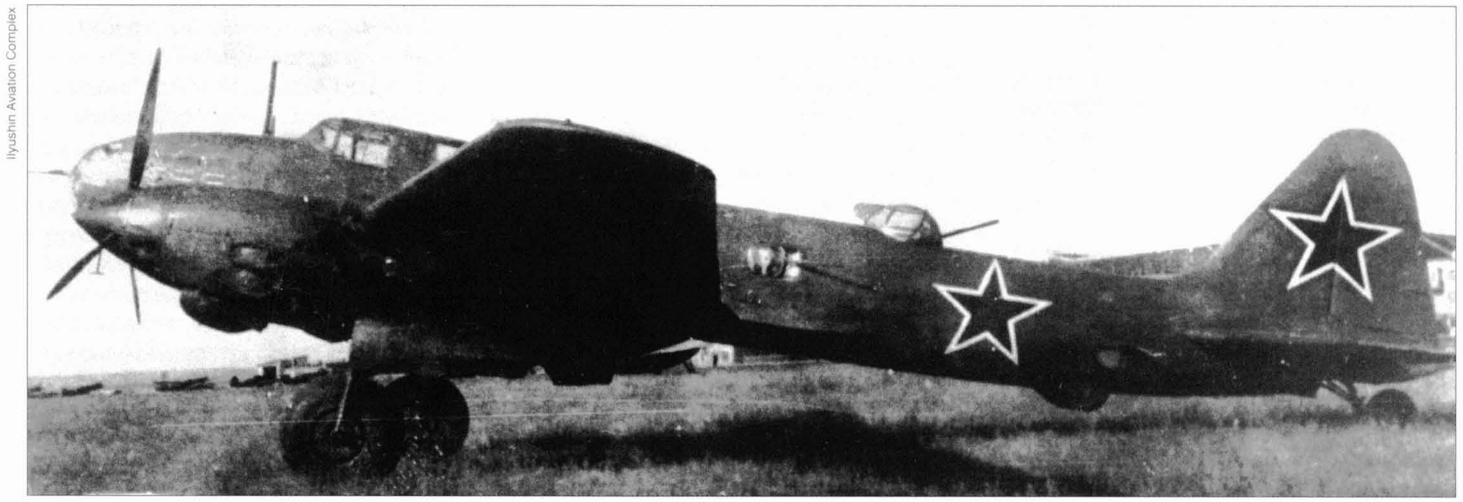
To achieve this, a determined production effort was required. One cause of alarm was the fact that the Soviet aircraft industry produced only 757 DB-3s and DB-3Fs during the whole of 1941. Several plants that had manufactured the bomber were evacuated to Siberia, and it took some time before they could resume their work at the new sites. The production capacity of the remaining Plant No.126 in Komsomol'sk-on-Amur was totally inadequate. Therefore, in March 1942, following a government decision, IL-4 production was organised at a factory in Fili, Moscow (the plant was returned from Siberia and designated Aircraft Plant No.23). Another decision of crucial importance was to stop Pe-2 production in Irkutsk in favour of the IL-4. As a result, 858 aircraft had been built by the end of that year.

The overall production record of the type was impressive. To 1,528 DB-3s were added 5,256 DB-3Fs and IL-4s, the last 160 of which were produced after the war. Until Victory Day the IL-4 formed the basis of the Soviet ADD, reorganised in 1945 into the 18th Air Army. During the war the ADD performed a wide variety of operational tasks. Among these, bombing raids against strategic targets were of primary importance. These were supplemented by missions intended to block enemy airfields and frustrate Luftwaffe's operational activities. Long-range strategic reconnaissance was also a matter of considerable importance. The IL-4s of the Naval Air Arm were widely used for mine-laying and for torpedo attacks against enemy combat ships and transport vessels.

The most distinguished ADD pilots who flew DB-3s and IL-4s were rewarded during the war with the highest military decorations; S. Kretov, Aleksandr Molodchiy, E. Fedokov, V. Osipov and Pavel Taran became Heroes of the Soviet Union. Navigators and gunner/ radio operators were seldom given awards in the Soviet VVS, but an IL-4 navigator, V. Sen'ko, was twice made Hero of the Soviet Union.

IL-6 long-range bomber

The IL-6 bomber was conceived as a replacement for the IL-4 with the same range and normal bomb load, but with an appreciably greater speed, more potent defensive



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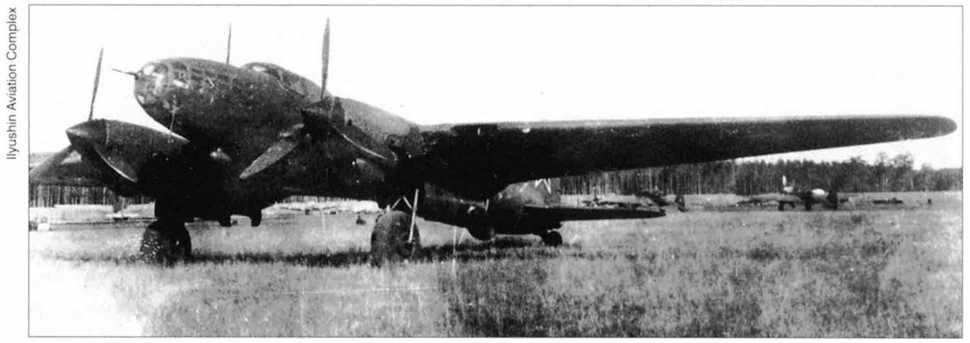
A side view of the sole IL-6 prototype, showing clearly the considerable leading-edge sweep and the beam machine-gun blisters.

armament and better crew protection. The aircraft was to be powered by two Shvetsov M-71 radials delivering 2,000 hp for take-off. In August 1942 the OKB completed the advanced development project of the ASh-71-powered IL-6. It was generally approved by NII VVS, but the Air Force command asked the designers to increase the range and replace the M-71 engines (which were at an early test stage) with Charomskiy ACh-30B diesels. These engines, with their low fuel consumption, were expected to facilitate obtaining the specified range. It was a boosted version of this engine, the ACh-30BF with a take-off rating of 1,900 hp, that was finally chosen for the IL-6. The reworked advanced development project was completed in December 1942, and preparations were started for the prototype construction.

When designing the IL-6, the OKB sought to retain as much of the IL-4's structure as possible. In side view the IL-6 strongly resembled its predecessor, differing outwardly in a somewhat longer and slimmer fuselage. However, the wings were an all-new structure of a totally altered planform; they featured a straight trailing edge coupled with moderate sweepback on the leading edges and pronounced taper. The aspect ratio was increased to 8. The engines were housed in streamlined nacelles, the coolant radiators being buried in the wing centre section, with leading edge slit air inlets.

The defensive armament comprised five flexible cannon installations, each with a 20-mm Shpital'nyy Sh-20 cannon. These included a flexible nose gun operated by navigator, a dorsal turret, a rearward-firing gun in a ventral position and two beam gun blisters. Accordingly, the crew was increased to six: two pilots, a navigator, two gunners for the dorsal turret and the ventral gun and a gunner operating the two beam



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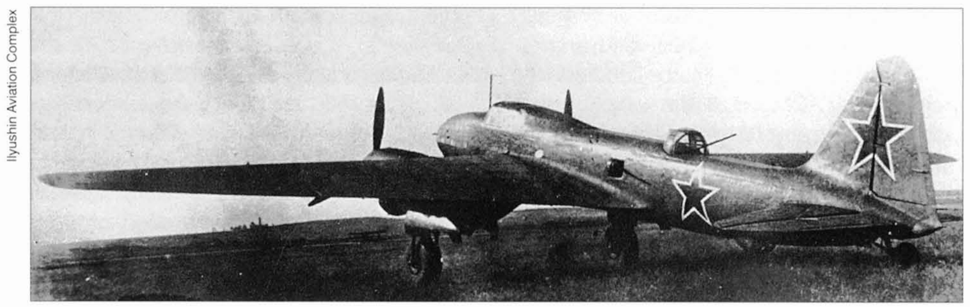
Above and below: Two more views of the IL-6. The aircraft looked like an overgrown IL-4 – which, in actual fact, it was.



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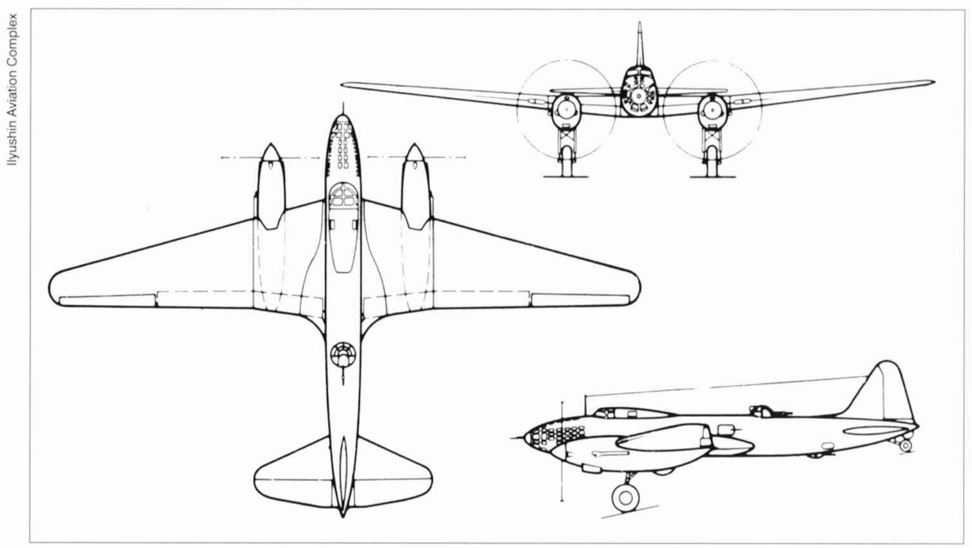

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A three-view drawing of the IL-6.

Specifications of the IL-6 bomber

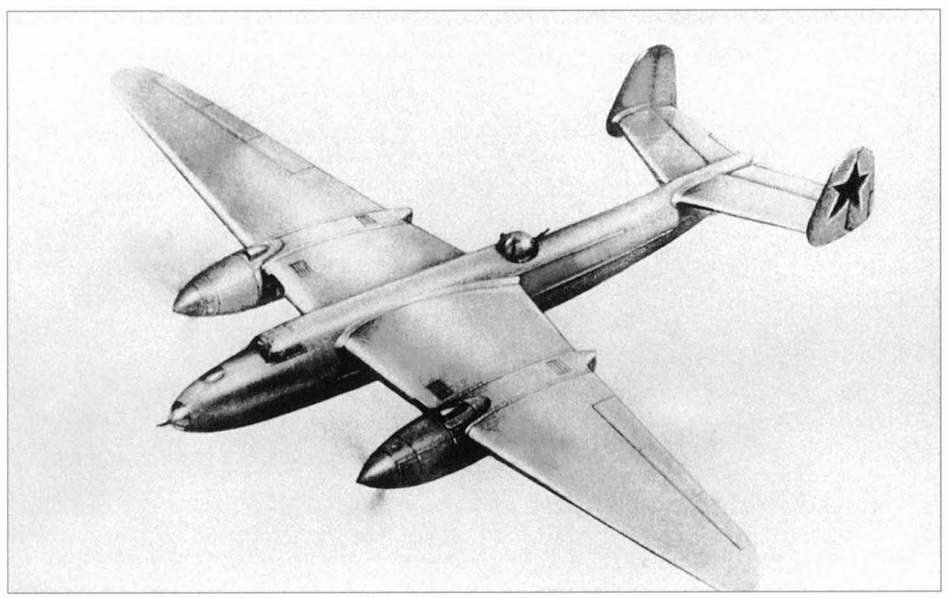
Year	1943	1944
Engine type	ACh-30B	ACh-30BF
Take-off power, hp	2 x 1,500	2 x 1,900
Wing area, m² (sq ft)	84,8 (912.9)	84,8 (912.9)
Crew	4	5
All-up weight, kg (lb):		
normal	15,600 (34,400)	16,100 (35,500)
maximum	18,650 (41,130)	19,600 (43,220)
Maximum speed, km/h (mph):		
at sea level	382 (237)	400 (249)
at rated altitude	445 (277) (6,600 m/21,655 ft)	464 (288) (6,200 m/20,340 ft)
Time to 5,000 m (16,400 ft), minutes	15.7	28.7
Service ceiling, m (ft)	8,000 (26,250)	7,000 (22,970)
Range, km (miles):	5,450 (3,387)	5,450 (3,387)
at a speed of, km/h (mph)	340 (211)	340 (211)
with a bomb load of, kg (lb)	1,000 (2,205)	1,000 (2,205)
Take-off run, m (ft)	600 (1,970)	730 (2,395)
Landing speed, km/h (mph)	135 (84)	139 (84)
Bomb load, kg (lb):		
normal	1,000 (2,205)	1,000 (2,205)
maximum	4,500 (9,920)	4,500 (9,920)
Defensive armament, cannon, mm	3 x 20	5 x 20

guns. All crew members were provided with armour protection.

The aircraft could carry a bomb load of up to 2,500 kg (5,510 lb) internally; on external racks it could carry two 1,000-kg (2,205 lb) bombs or two torpedoes.

The IL-6 prototype made its maiden flight in Irkutsk on 7th August 1943. The originally specified ACh-30BF engines were unavailable, and the aircraft had to be fitted with the lower-rated ACh-30Bs, with which it was clearly underpowered. In consequence, the flight testing was started without the beam guns and their operator. The aircraft was dismantled and sent by rail to Moscow where the testing resumed in the spring of 1944.

The aircraft manifested certain piloting vices which made its handling difficult and even dangerous, necessitating a number of modifications. In the period between May and July 1944 the IL-6 was re-engined with the ACh-30BF diesels, as per project, enabling the designers to equip it with the full armament complement, including the waist gun positions. After a few initial flights elevator area was reduced and the CG shifted slightly aft. Thus modified, the IL-6 resumed flight tests in August 1944; they were completed on 10th October 1944. During these test flights the IL-6 attained a maximum speed of 464 km/h at a normal gross weight of 16,100 kg (35,500 lb). The range with a 1,000-kg (2,205-lb) bomb load carried internally, at a cruising speed of 340 km/h (211 mph) and an overload AUW of 18,150 kg (40,020 lb) was 5,450 km. The modified aircraft's handling was considerably improved; yet, it still displayed the tendency to an overly steep glide path and poor controllability during a landing approach in a high AUW configuration. This was traced to some faults in the wings' aerodynamic configuration. As for the ACh-30B engines, they worked reliably during the flight testing, but presented some operational problems, such as difficult start-up in low ambient temperatures and poor acceleration. All this eventually resulted in the termination of work on the IL-6.



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An artist's impression of the twin-tailed version of the DB-4 (TsKB-56). The large ailerons and small outboard flap sections are noteworthy.

IL-6 bomber with M-90 engines (project)

Concurrently with the work on the IL-6 powered by M-30B (ACh-30B) diesels described above Ilyushin was engaged in developing an IL-6 (presumably the same airframe as above) which was to be fitted with the more powerful M-90 engines. An order issued by NKAP on 6th February 1943 tasked the director of Plant No.39 with building *'two prototype IL-6 (modified IL-4) aircraft with the M-90 engines'*; they were to be submitted for factory flight testing on 1st June and 1st July 1943. Ilyushin stated in a document dated 26th February 1943 that a set of manufacturing drawings for a reworked version of the IL-4 (IL-6) designed to accept the M-90 engines was ready. Manufacturing drawings for the M-30-powered version of the IL-6 were not yet completed at that moment. Ilyushin quoted design performance characteristics which showed that the M-90-powered version would have a considerably greater speed, while possessing a somewhat inferior range as compared to the diesel-powered competitor. He suggested that two prototypes be completed, one with M-90s and the other with M-30s. Manufacturing drawings for the M-90-powered IL-6 were transferred to the production shops of Plant No.39 on 20th March 1943 (those for the M-30-powered version followed in April). Further available documents contain no references to the M-90-powered version of the IL-6 which presumably was abandoned in favour of concentrating all effort on the diesel-powered version.

DB-4 (TsKB-56) long-range bomber

In the late 1930s the Soviet Government tasked the aircraft industry with creating new, more advanced combat aircraft designs within the framework of a programme intended to result in re-equipping the Red Army Air Force with more potent machines. In 1939, pursuant to this programme, the Ilyushin OKB started full-scale

design work on a new bomber which was to supersede the DB-3 (preliminary studies on the project had been initiated by the design bureau in March 1938). The design specifications called for a bomber with considerably superior performance and combat characteristics: it was to possess higher speed, a greater bomb load and more efficient defensive armament.

The design evolved by the Ilyushin OKB was allocated service designation DB-4; in-house it was known as the TsKB-56. It was a twin-engined monoplane featuring sleek contours. An available OKB drawing depicts it as a high-wing aircraft; this layout was prompted by the need to provide enough space in the bomb bay for large-calibre bombs. (Surprisingly, some published drawings show a mid-wing aircraft). The moderately tapering wings had a greater area compared to the DB-3, to allow for the greater all-up weight of 13 tonnes (28,665 lb) while retaining the same wing loading. In order to obtain the highest lift coefficient, the wings incorporated a set of different airfoils; the extreme outboard sections of the wing panels had greater camber than the inboard sections.

As usual, the crucial question in determining the shape (and the fate) of the design was the choice of powerplant. The project envisaged the installation of two new M-120 water-cooled engines developed by Vladimir Ya.Klimov; their high take-off power rating (1,800 hp) was achieved by increasing the number of cylinders to 18 in a Y-layout. An engine of similar layout (the AM-36) was also developed by the Mikulin engine design bureau. However, Mikulin was well aware of the inherent drawback of this engine layout resulting in an overly big cross-section and accordingly high drag. Therefore he decided to develop concurrently an engine of the usual V-type which would deliver 1,400 hp at an altitude of 5,800 m (19,030 ft). This engine came to be known as the AM-37. Thus, by the time the DB-4 (TsKB) began to take shape, its designers had a choice of two new engines – the M-120 and the AM-37. The design performance of the M-120-powered aircraft was quite impressive – the bomber was expected to attain a maximum speed of 570 km/h (354 mph) at an altitude of 7,000 m (15,435 ft) and a ceiling of 11,000-12,000 m (36,090-39,370 ft). (Specifications issued by the military called for a speed of 550 km/h (342 mph), a 1,000-kg (2,205-lb) bomb load and a range of 4,000 km (2,486 miles).)

In its original project version, the DB-4 featured a tail unit with twin endplate fin-and-rudder assemblies; it was believed to provide a better field of fire for the dorsal gunner. Into the bargain, this arrangement was expected to enhance the efficiency of the vertical tails, since they were placed in the wake of the propellers. To the designers' disappointment, wind tunnel test revealed that in the case of an engine failure the efficiency of the vertical tails diminished drastically. Therefore Ilyushin tasked his staff with developing, as an insurance policy, also a conventional tail unit for the second prototype of the new bomber.

Much attention was devoted by Ilyushin to the aircraft's defensive armament. In its initial version, it was identical to that of the DB-3F (IL-4) and comprised three ShKAS machine-guns: one for the nose gunner, one in the MV-3 dorsal turret and one in a ventral hatch installation. In production the MV-3 turret was to be replaced with a turret with twin ShKAS machine-guns.

The bomb load amounting to 1,000 kg (2,205 lb) comprised ten FAB-100 high-explosive bombs stowed internally. Alternatively, the aircraft could carry three 250-kg (551-lb) FAB-250s or one FAB-1000.

The bomber was provided with the most up-to-date set of navigation equipment.

Teething troubles that plagued the very immature M-120 engine called into question the wisdom of installing it on the prototype DB-4. On 7th August 1940 the Defence Committee authorised the installation of the more reliable AM-37 engines on the new bomber. NKAP followed up with appointing a commission to check the readiness of the AM-37-powered DB-4 for the first flight. Yet, one of the two DB-4 prototypes was fitted, as originally planned, with the M-120 engines; featuring the twin-fin tail unit, it was completed at the end of 1940. The other example equipped with a single fin-and-rudder assembly was powered by AM-37 engines. It was the AM-37-powered example that was the first to be ready for flight test; it was rolled out on 23rd August and took to the air for the first time on 15th October 1940, piloted by Vladimir Kokkinaki.

The testing revealed two basic deficiencies of the new bomber – insufficient directional stability, especially at low speeds, and unsatisfactory torsional stiffness of the fuselage due to the overly large cutout for the bomb bay. The latter deficiency manifested itself in strong vibrations and torsional deformations in flight. The situation was promptly remedied. The vertical tail area was increased; the fuselage was strengthened by means of fitting four high-rigidity spars made from pressed channel-section profiles to the inside of the skinning (two on each side of the monocoque rear fuselage).

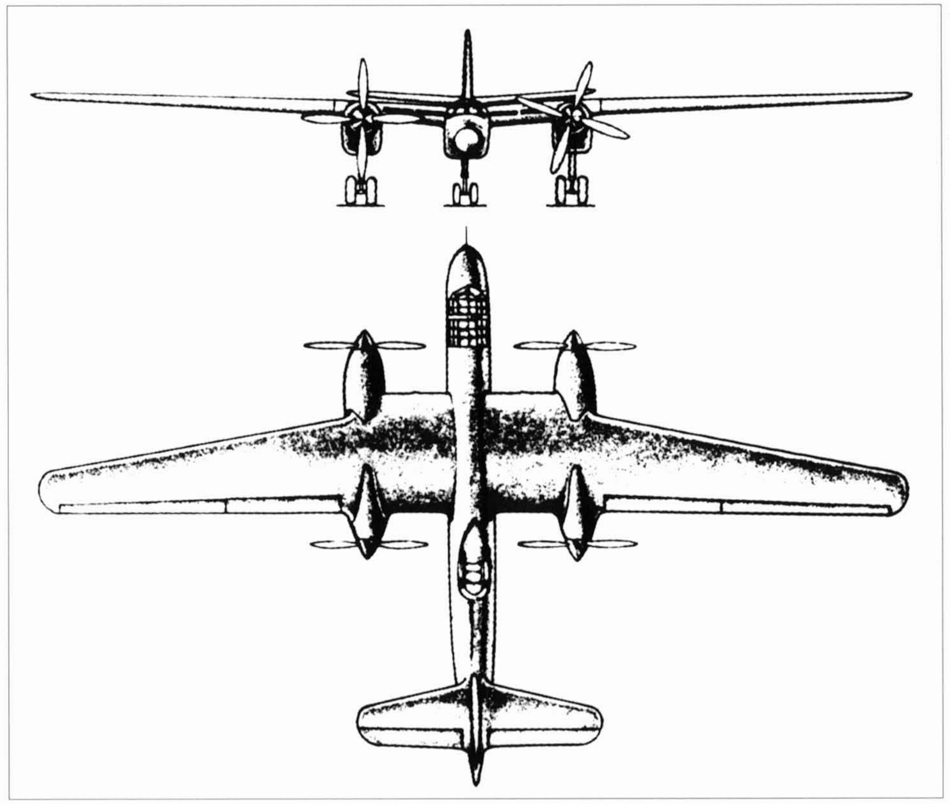
An interesting feature of the prototype was its powerplant. The AM-37 engines were housed in sleek nacelles; to reduce their cross-section, the coolant radiators were placed in the rear of the nacelles right aft of the mainwheel wells. The cooling air stream entered via louvres on each side of the nacelle and, having passed through the radiators, left the nacelle via an outlet closed by hinged flaps which were used for controlling the coolant temperature.

Specifications of the DB-4 (TsKB-56) bomber

Engine type	AM-37
Take-off power, hp	2 x 1,400
Wing area, m² (sq ft)	83 (893.5)
Crew	4
All-up weight, kg (lb):	
normal	10,806 (23,827)
maximum	13,006 (28,678)
Maximum speed, km/h (mph):	
at sea level	415 (258)
at 6,000m (19,686 ft)	500 (311)
Service ceiling, m (ft)	10,000 (32,800)
Range, km (miles), with a bomb load of 1,000 kg (2,205 lb)	4,000 (2,486)
Bomb load, kg (lb):	
normal	1,000 (2,205)
maximum	3,000 (6,610)

The second machine was completed in late November 1940 and, as mentioned above, was fitted with M-120 engines. However, there is no evidence that it was flown with these engines. A report states that on 17th December 1940 the second prototype DB-4 powered by AM-37 engines (re-engined?) entered the factory test stage (presumably pre-flight development). It did not make its first flight until 20th February 1941. Unfortunately, it made only a few flights before the testing was discontinued. The AM-37 engines, too, proved troublesome, causing interruptions in the testing of both prototypes. Lengthy delays in the flight test programme were also caused by numerous modifications to both prototypes which entailed, in particular, the fitting of new tail surfaces. The first prototype was fitted with new outer wing panels featuring increased leading edge sweepback. On the second prototype the twin-ShKAS dorsal turret was replaced by a single 20-mm ShVAK canon installation.

In the quest for a reliable powerplant for the DB-4, Ilyushin gave consideration to several other engine types. One of them was the Shvetsov M-71 radial air-cooled engine with a take-off rating of 2,000 hp. The M-71-powered version of the DB-4 was expected to attain a speed of 500 km/h (311 mph) at 5,000 m (16,400 ft). The OKB prepared the necessary drawings and technical documents for this version, but it did not reach the hardware stage. Some sources claim that Ilyushin was somewhat sceptical about the M-71 engines and gave preference to the



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Above: Two views of the projected IL-14 bomber – the first aircraft to bear this designation.

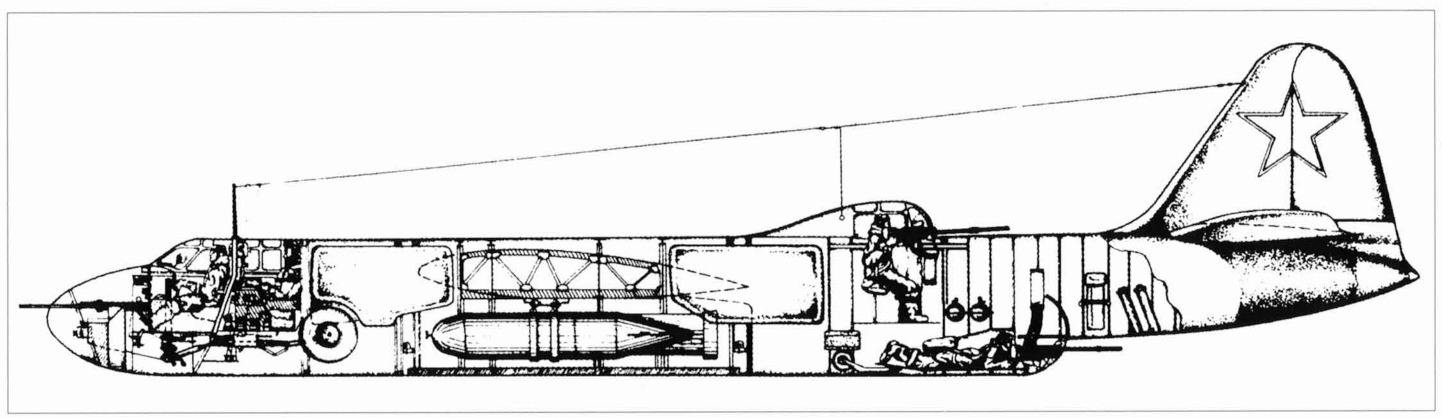
M-82 radials, also a product of the Shvetsov Design Bureau. Yet another option was the ACh-30B diesel engine rated at 1,300 hp; an attempt was allegedly made to fit the diesel engines to the DB-4.

The outbreak of the war with Germany sealed the fate of the DB-4. The design bureau, which had already been overburdened with the work on the IL-2 attack aircraft, had no resources for an active development of the prototype bomber. To make matters worse, the production plant which had previously been tentatively allocated for the series manufacture of the DB-4 with AM-37 engines was evacuated from Moscow and committed to the production of the IL-2 attack aircraft and the IL-4 bomber. As a consequence, further development of the DB-4 was abandoned.

IL-14 bomber (project)

The unsuccessful IL-6 bomber was the last piston-engined bomber to reach the hardware stage, but not the last to be designed by the Ilyushin OKB. For quite some time the OKB went on developing projects of that kind. In the spring of 1944 design work was started on a project of a high-speed bomber intended to replace the IL-4. It was allocated the designation IL-14 (the first use of the designation). The speed was to be high indeed: the bomber was expected to attain 700 km/h (435 mph).The IL-14 featured a very unorthodox layout. It was a high-wing monoplane powered by four Mikulin AM-43 liquid-cooled Vee-12 engines mounted in two tandem packages at the ends of the wing centre section. In each tandem pair, the forward engine drove a tractor propeller, whilst the rear engine drove a pusher propeller. The outer wing panels had a straight trailing edge and moderate leading-edge sweepback and featured a fairly high aspect ratio. The wing centre section had straight leading and trailing edges; its chord was extended well forward compared to the outer panels. The wing leading-edge sections between the engine nacelles and the fuselage housed coolant and oil radiators with leading-edge slit inlets. The aircraft had a conventional tail unit. It was to be fitted with a tricycle undercarriage with twin wheels on all three units. The main landing gear units were retracted into the engine nacelles and were stowed between the engines. The nose unit was aft-retracting. The tandem arrangement of the engines necessitated the introduction of a fourth landing gear strut intended to prevent the rear propellers from striking the ground during rotation on take-off. This strut was placed in the rear fuselage; when extended, it did not touch the ground while the aircraft retained a normal angle of attack on take-off or landing.

The aircraft had a crew of two (pilot and navigator/bomb-aimer). In the first version of the project no defensive armament was envisaged, the assumption being that the high speed of the aircraft would afford sufficient protection. However, when Air Force specialists reviewed the project in July 1944 they disagreed with Ilyushin over this point. The OKB was asked to introduce alterations and provide the bomber with both defensive and offensive armament. The reworked version of the project met these wishes while retaining the basic features of the original design, including its unorthodox engine arrangement. The crew complement was increased accordingly and comprised four persons. The pilot and navigator were accommodated under a common canopy in the front cabin; the pilot operated the fixed forward-firing cannon mounted in the nose. One of the two gunners manned a dorsal turret placed amidships and fitted with a flexible cannon; another flexible cannon and its gunner were placed in a ventral installation further aft to protect the aircraft from attacks from the lower rear hemisphere. The aircraft could carry a maximum bomb load of 2,500 kg (5,510 lb).



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This cutaway drawing shows the internal layout of the IL-14 bomber. Note the stepped arrangement of the ventral cannon barbette.

The new version of the project was to be powered by four AM-43NV engines rated at 2,460 hp for take-off. (According to some reports, the IL-14 was to be fitted with the 2,500-hp M-45 engines). With the AM-43NVs, the aircraft had a normal AUW of 22,400 kg (49,390 lb); it was intended to attain a maximum speed of 760 km/h (472 mph) at 9,300 m (30,510 ft).

In 1945 construction of the prototype was started. The unfinished aircraft was reviewed by a State commission which generally approved the design and recommended that the bomber's armament be strengthened by installing twin-cannon dorsal and ventral turrets affording an all-round field of fire. However, the aircraft was never completed. After the end of the Second World War a decision was taken to discontinue the work on the project.

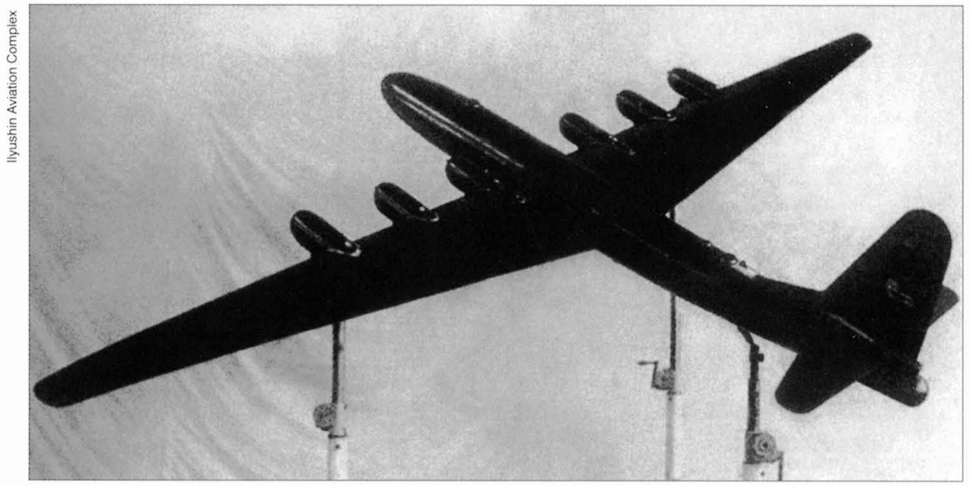
Specifications of the IL-14 bomber (design performance)

Engine type	AM-43NV
Take-off power, hp	4 x 2,460
Wing area, m² (sq ft)	83.8 (902.1)
Crew	4
All-up weight, kg (lb):	
normal	21,500 (47,407)
maximum	22,250 (49,061)
Maximum speed, km/h (mph):	
At sea level	600 (373)
At 9,300 m (30,510 ft)	760 (472)
Time to 5,000 m (16,405), min	5.0
Practical ceiling, m (ft)	12,500 (41,010)
Range, km (miles)	
with a 2,000-kg (4,410-lb) bomb load	2,500 (1,553)
Take-off run, m (ft)	560 (1,837)
Bomb load, kg (lb):	
normal	2,000 (4,410)
maximum	2,500 (5,512)
Defensive armament (cannon), mm	1 x 23 2 x 20

An attempt was made to use this project as a basis for the design of a heavy long-range fighter intended to counter the threat posed by the US Boeing B-29 and B-50 bombers. The fighter was to be fitted with a radar and a potent complement of armament comprising two 45-mm cannon. However, a shift of emphasis in favour of surface-to-air missiles as a means of anti-aircraft defence resulted in the termination of work on this project, too.

IL-26 strategic bomber (project)

The deteriorating relationship between the Soviet Union and its former allies after the end of the Second World War and the ensuing Cold War resulted in the build-up of military power on both sides of the Iron Curtain. As a part of the response to the presumed Western threat, the Soviet Government initiated programmes envisaging the development of long-range strategic bombers capable of reaching targets on the territory of the USA. In 1947 appropriate specifications were issued to design bureaux led by Andrey N. Tupolev and Sergey V. Ilyushin.



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This wind tunnel model illustrates one of the project configurations of the monstrous IL-26 bomber.

The new bomber project was allocated the designation IL-26 in the Ilyushin OKB. Actually, this designation covered a whole series of projects possessing a common basic layout but differing in the type and number of engines and, accordingly, in overall dimensions. The engines that came under consideration included the 4,500 hp Shvetsov ASh-2TK piston engines, the 6,000 hp Yakovlev M-501 diesel engines and the 5,000-hp Klimov VK-2 turboprops. Although the project work was started after the introduction of jet fighters into service, the use of piston engines for the new bomber was regarded as justified on the assumption that it would be provided with enhanced and efficient defensive armament.

In all its versions, the IL-26 featured straight wings of very high aspect ratio and a normal single-fin tail unit; the powerplant comprised four or six engines mounted on the wing leading edge. It could carry a bomb load of 12,000 kg (26,460 lb); the bomb bay of the IL-26 could accommodate one 10-tonne (22,050-lb) bomb or four 3-tonne (6,610-lb) bombs. Protection from enemy fighter attack was ensured by two dorsal and two ventral cannon turrets supplemented by a tail turret, all of them fitted with 23-mm (.90 calibre) Sh-3 cannon.

An interesting feature of one of the versions was its undercarriage. The enormous amount of fuel consumed by the aircraft resulted in a big difference between the take-off weight and the landing weight; this prompted the designers to provide the bomber with auxiliary underwing undercarriage struts which could be jettisoned after take-off. This made it possible to reduce the aircraft's weight and increase its range.

Comprehensive studies and wind tunnel tests showed that the VK-2 powered version of the bomber had indisputable advantages over the versions with other engine types, as far as range and speed were concerned. The range in this case was expected to be no less than 11,560 km (7,185 miles). However, further studies and design work on this bomber were halted because Ilyushin was ordered to concentrate the resources of his design bureau on the testing of the IL-28 bomber and its production launch. Work on strategic bombers was never resumed by the Ilyushin OKB, remaining for some time the exclusive domain of A.N. Tupolev (later shared also by Vladimir M. Myasishchev and, to some extent, Pavel O. Sukhoi).

Specifications of the IL-26 strategic bomber (design performance)

Engine type	VK-2
Take-off power, hp	6 x 5,000
Wing area, m² (sq ft)	475 (5,113)
Crew	12
All-up weight, kg (lb):	
normal	190,000 (418,950)
Maximum speed, km/h (mph):	
at sea level	545 (339)
at 9,300 m (30,510 ft)	560 (348)
Practical ceiling, m (ft)	10,000 (32,800)
Range, km (miles) with a 5,000-kg	(11,025-lb)
bomb load	11,560 (7,185)
Take-off run, m (ft)	1,520 (4,987)
Bomb load, kg (lb):	
normal	5,000 (11,025)
maximum	12,000 (26,460)
Defensive armament (cannon), mm	10 x 23

IL-22 tactical bomber prototype (first use of designation)

In 1946 the Soviet Air Force started taking delivery of its first jet fighters (the Yakovlev Yak-15 and the Mikoyan/Gurevich MiG-9). The rapid re-equipment of fighter units both in the Soviet Union and abroad created the necessity to introduce jet propulsion on bombers as well.

By the time jet aircraft development began in the Soviet Union, Soviet aviation experts had obtained sufficient information about German work in this field; from Western trade magazines they could glean further information about heavy jet aircraft developed in the USA and Great Britain. Still, while this knowledge gave some food for thought, the Soviet Union had no prior experience of designing, building and operating such aircraft.

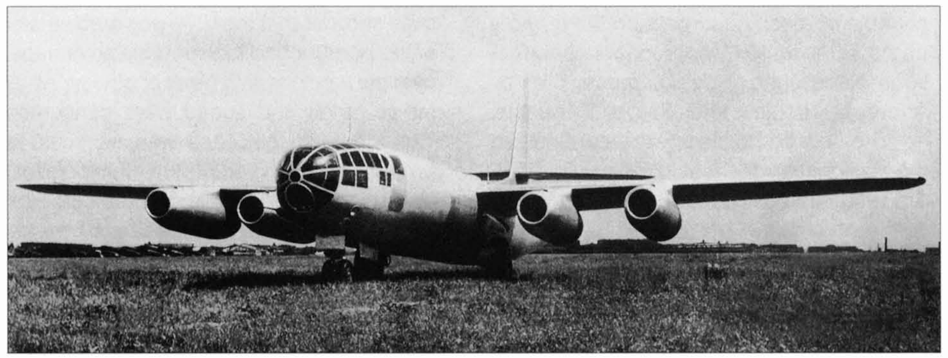
The task of creating a fully capable short-range (tactical) jet bomber to replace the obsolete Second World War-vintage piston-engined types was quite a complicated one due to the early turbojet engines' high specific fuel consumption, which was nearly five times higher as compared to the piston engines of the time. This meant the fuel load had to be increased appreciably, which in turn necessitated a lot of research in order to determine the jet bomber's optimum dimensions and weights and select the optimum layout. The latter meant a layout which would give the aircraft an adequate warload at the specified speed and range while still affording enough room for installing potent defensive armament and mission avionics that would enable the bomber to accomplish the mission in the daytime and at night, in the face of the adversary's air defences and fighters.

In order to find practical solutions to the problems associated with the development of heavy multi-engine jet aircraft the Soviet Council of Ministers issued a directive on 12th February 1946, ordering Sergey V. Ilyushin's OKB-240 to develop and submit for trials a bomber designated IL-22 and powered by four Lyul'ka TR-1 axial-flow turbojets. The aircraft was to have a 2,000-kg (4,410-lb) normal bomb load, a range of 1,250 km (776 miles), a cruising speed of 750 km/h (465 mph) and a normal take-off weight of 24 tons (52,910 lb). In maximum take-off weight (overload) configuration the range increased to 2,000 km (1,240 miles); the top speed was to be 800 km/h (496 mph) at 9,000 m (29,530 ft) and the maximum Mach number 0.75.

The design team of OKB-240, which was then quite small, set to work on the OKB's first jet aircraft. The preliminary design (PD) stage lasted from June to October 1946; work on the advanced development project (ADP) commenced in November. Despite the complexity of the project and the fact that Ilyushin had no prior experience with jets, the project was completed in an incredibly short time; the Soviet Union's first four-turbojet bomber incorporating a whole range of pioneering design features was ready for flight tests just a year after its inception.

The specified speeds made it possible to use a conventional aerodynamic layout with mid-set cantilever unswept wings and unswept tail surfaces; however, special measures were taken to minimise drag and offset the effects of the changes in the wing lift and longitudinal stability at high speeds. The IL-22 featured thin wings with an area loading of 310-350 kg/m^2 (63.5-71.75 lb/sq ft); the wings utilised symmetrical high-speed airfoils with a thickness/chord ratio of 12% and a maximum thickness at approximately 40% of the chord. The root sections featured the TsAGI 1A-10 airfoil generating relatively modest lift, while the outer wings used the TsAGI 1V-10 airfoil creating high lift. Apart from alleviated the harmful effects of the shock wave crisis, this wing design improved lateral stability at high angles of attack, preventing the onset of tip stall.

Flight tests of early jet fighters revealed a phenomenon known in Russian as *val'ozhka* – a tendency to drop a wing uncommandedly at high speeds and high altitudes. The cause of the trouble was traced to manufacturing inaccuracies (as it were, the port and starboard wings had slightly different airfoils generating different amounts of lift) which did not have any major effect on the aircraft's stability and handling at lower speeds. Recognising the problem, the Ilyushin OKB took great pains to ensure that the IL-22's wings were manufactured with a high degree of precision to preclude *val'ozhka* without resorting to methods causing a major increase in manufacturing complexity and labour intensity. At Sergey V. Ilyushin's initiative a new technology was devised for manufacturing the wings, tail unit and some components of the fuselage structure. This technology, which found its first practical application on the IL-22 prototype, involved using the aircraft's skin as a reference point – that is, in order to ensure the correct contours, the internal structural members were attached to the skin panels which were fixed in the assembly jig, not vice versa as had been customary until then. This was made possible by introducing manufacturing joints along the wings' and tail surfaces' chord lines, thereby splitting the ribs and spars in two. The same technique was used for manufacturing the forward and rear fuselage sections which were split vertically along the centreline, just like the average plastic model kit. At the price of a very small weight penalty this technology not only ensured that the correct airfoils and fuselage contours were observed but also simplified and accelerated the assembly process greatly, allowing the internal equipment to be installed in the halves of the major airframe subassemblies before these were joined together. This allowed several teams to work on a single subassembly at once and accounted in no small degree for the rapid completion of the prototype.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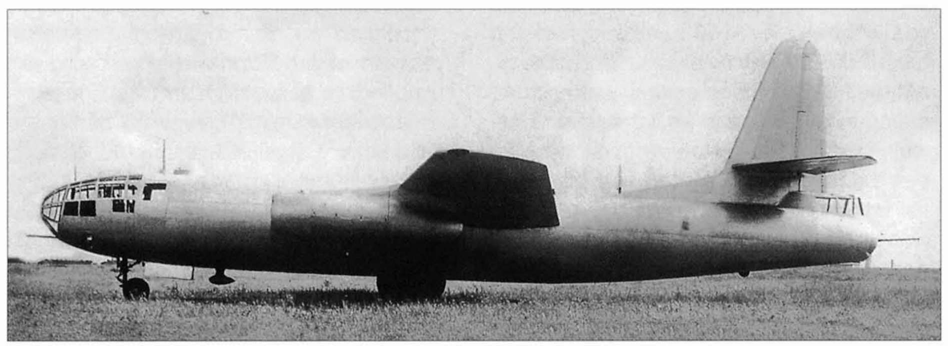
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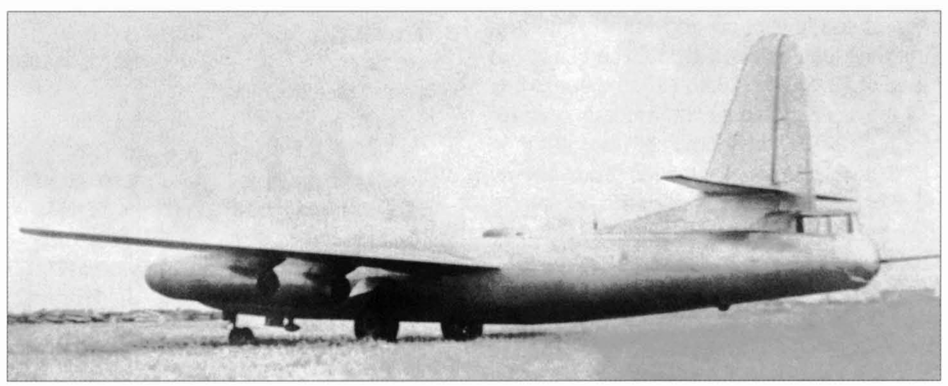
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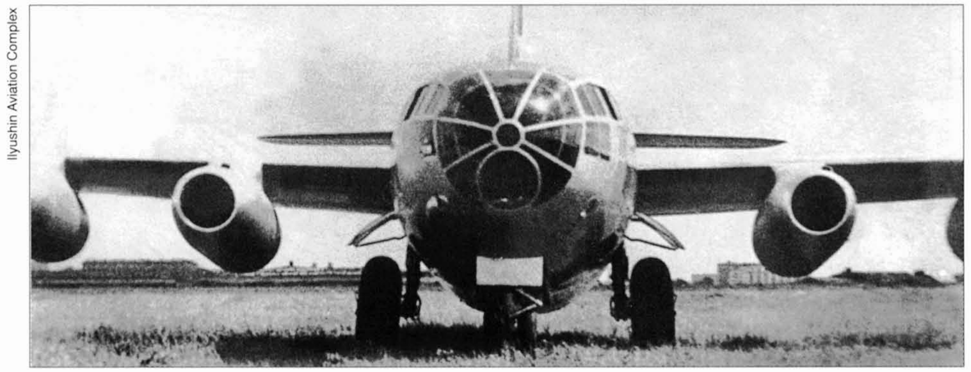
Top, centre and above: The IL-22 prototype during trials. These views illustrate the bomber's extremely small ground clearance and the position of the engines relative to the wings. Note the lack of insignia.

The layout of the IL-22's tail unit was chosen with the peculiarities of high-speed flight in mind. Its parameters, which were selected with a view to providing the required stability and control characteristics, ensured the onset of the shock wave crisis on the tail surfaces at higher mach numbers than on the wings. Hence the tail unit made use of even thinner symmetrical airfoils with a thickness/chord ratio of 9-10%. The tail surfaces were arranged in cruciform fashion, the stabilisers being mounted on the fin and placed outside the wing upwash.

Choosing the optimum engine placement, fuselage parameters and landing gear design, all of which were interrelated, turned out to be no easier than designing the wings and tail unit. The few multi-engine jet aircraft existing at the time featured widely varying engine arrangements, including some really weird ones; most of them, however, had the engines either buried in the wings or located (singly or in clusters) in nacelles adhering directly to the wing undersurface. The cluster or package arrangement offered certain advantages over individual nacelles, reducing overall drag and interference drag somewhat; hence it was widespread in 1945-47, finding use on such aircraft as the Arado Ar 234B-2 Blitz (Lightning) and the Junkers Ju 287 V-3 prototype, as well as the North American B-45 Tornado, Convair B-46 and Martin B-48. The latter three bombers entered flight test in 1947 concurrently with the IL-22.

However, the cluster arrangement had serious shortcomings as well. The reliability of the day's jet engines left a lot to be desired, and the uncontained failure and/or fire of one engine in a cluster could put the neighbouring engines out of action, too. Operational experience proved that this was often the case.

After analysing the merits and weaknesses of several alternative arrangements, including paired nacelles similar to those of the Ar 234B and B-45, the Ilyushin OKB developed an unusual layout with four widely spaced individual nacelles carried ahead of the wing leading edge on short horizontal pylons. The engines were attached solely to the pylons which transferred the loads to the wing structure, doubling as anti-flutter weights. This installation ahead of the wing leading edge turned out to be more efficient aerodynamically than the cluster arrangement. Also, it facilitated engine maintenance/change and allowed other engine types to be installed in case of need without requiring major changes to the wing structure – no small thing for an experimental aircraft, as the IL-22 was also effectively a testbed for the TR-1 turbojets. The podded underwing installation of jet engines on pylons later won universal recognition and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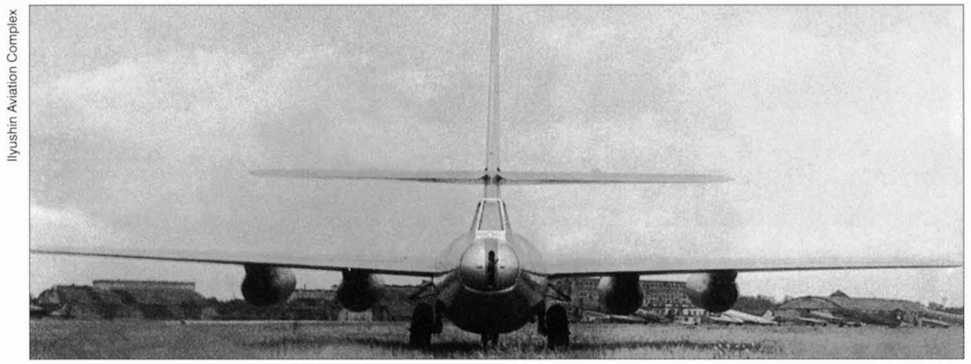
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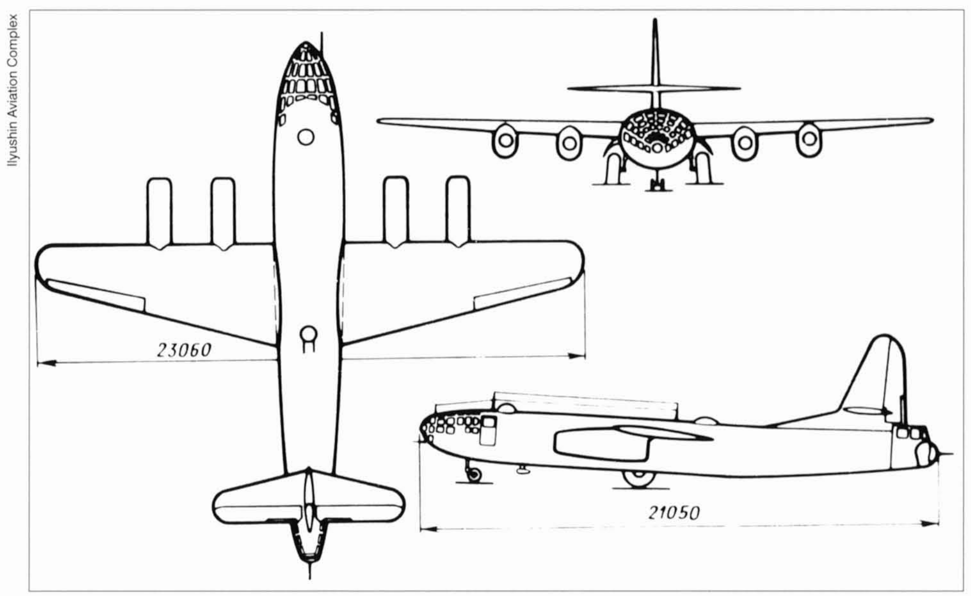
Top and above: These front and rear views illustrate the IL-22's oval-section fuselage and the extremely narrow landing gear track.



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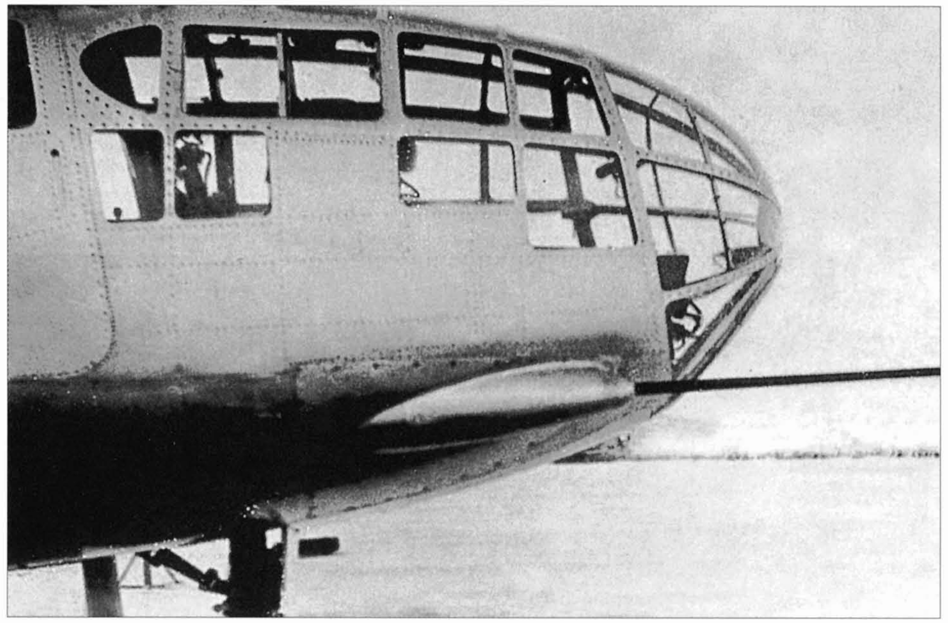
A three-view drawing of the IL-22.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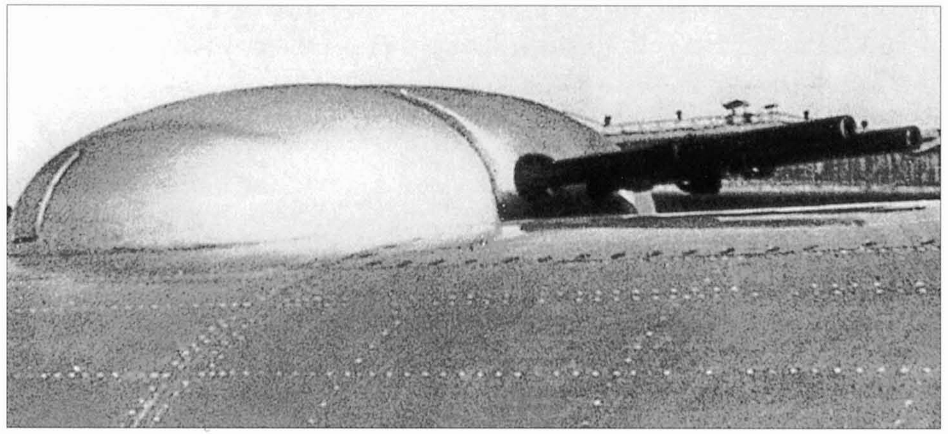
Above: Close-up of the IL-22's extensively glazed forward fuselage with a forward-firing cannon on the starboard side. Note the car-type flightdeck doors.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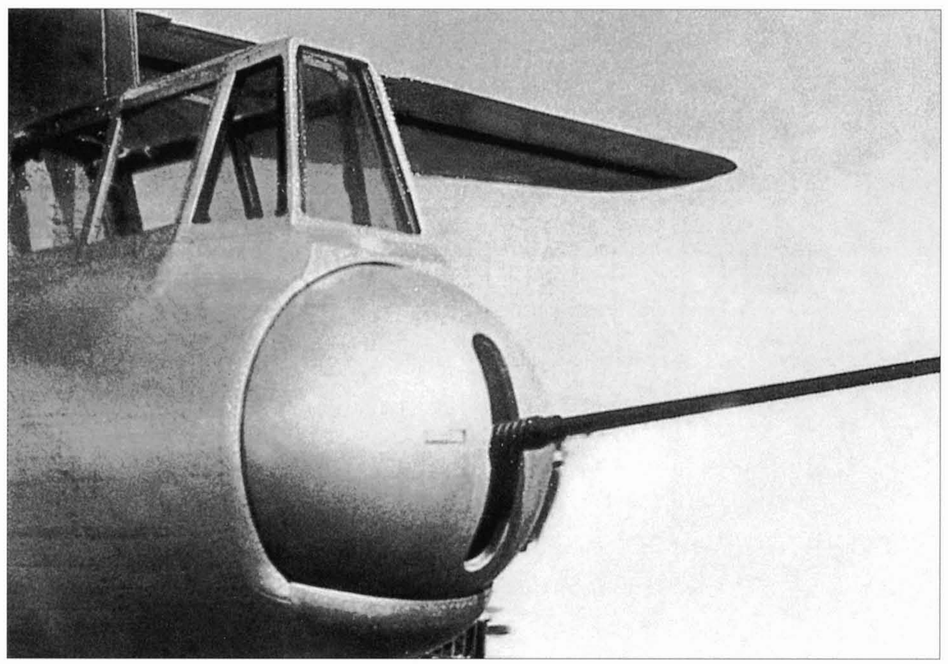
Above: The remote-controlled dorsal barbette of the IL-22. Note the heat-resistant steel plate riveted on aft of the cannon barrels to protect the skin from the blast.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The tail gunner's station and the IL-KU3 tail turret of the IL-22.

was widely used on commercial and military aircraft developed both in the Soviet Union (and subsequently the CIS) and abroad.

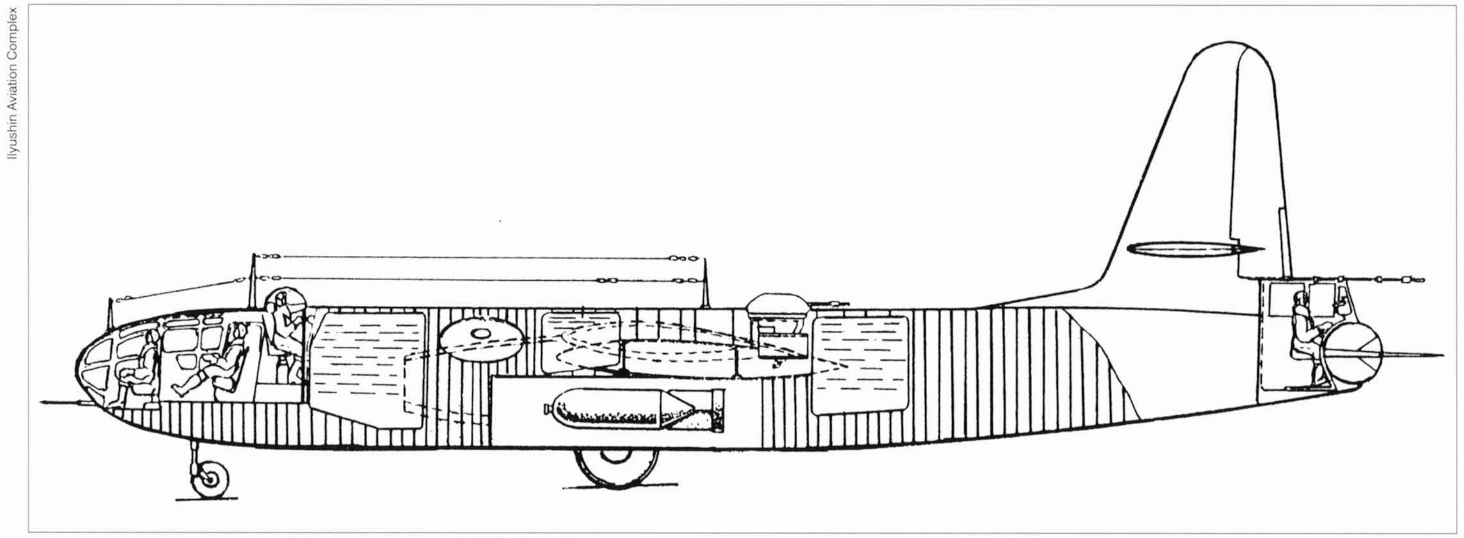
The TR-1 was a rather compact engine, and the neat nacelles could not possibly accommodate the large mainwheels which had been selected in order to enable operations from unpaved runways. Hence the forward-retracting main gear units were mounted on the fuselage; to widen the landing gear track in order to ensure acceptable stability and manoeuvrability on the ground the fuselage received an elliptical cross-section with the larger axis horizontal. The main gear fulcrums featured skewed axles to provide the widest possible track; due to this feature the single wheels turned during retraction to stow in V fashion, side by side, ahead of the bomb bay which accommodated up to 3 tons (6,610 lb) of bombs. The twin-wheel nose gear unit retracted aft.

The chosen fuselage cross-section facilitated the accommodation of other items, too. Thus the wide fuselage provided ample room for the crew of five. The two pilots sat side by side, with the navigator/bomb-aimer ahead of them and the radio operator/dorsal gunner aft; the tail gunner had a separate compartment aft of the tail unit all to himself. The fuselage housed three bag-type fuel tanks holding a total of 9,300 kg (20,500 lb) – a much greater fuel load compared to a piston-engined bomber having comparable range.

To minimise drag the designers chose not to use a stepped windscreen. The extensively glazed nose had a bullet shape reminiscent of the Boeing B-29 or the Arado Ar 234. The clean contours of the fuselage were broken only by a small observation/sighting blister and the dorsal cannon barbette further aft. The airflow speed and air pressure along the length of such a fuselage changed to a much lesser extent than in the case of, say, chordwise flow over the wings.

Speaking of armament, the IL-22's much higher speed as compared to piston-engined bombers meant that muscular force would not be enough to work the cannon barbettes, necessitating the use of electric and hydraulic drives. The IL-22 also benefited from a new approach to placing the defensive armament on the airframe with due regard to using remote controls (the barbettes were slaved to the gunsights). To check the efficacy of the powered barbettes and their remote control systems the aircraft was provided with a defensive armament comprising one fixed cannon and three cannon barbettes.

A single forward-firing 23-mm (.90 calibre) Nudelman/Suranov NS-23 cannon with 150 rounds was installed on the starboard side of the forward fuselage. It was to be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Above: A cutaway drawing of the IL-22 from the project documents, showing the retracted position of the mainwheels above the bomb bay and the three fuel tanks ahead of, above and aft of the bomb bay. Note the aerial above the tail gunner's station which was not fitted to the actual aircraft.

fired by the aircraft's captain who would use a primitive ring-type sight for aiming it.

The dorsal barbette mounted two 20-mm (.78 calibre) Berezin B-20E cannon with 400 rpg; it provided almost 360° coverage of the upper hemisphere and was controlled electrically by the radio operator, electric motors being used for both traversing and elevating. The cannons were slaved to the gunsight in the dorsal blister; special microswitches interrupted the cannon fire when the barrels pointed aft so as to avoid shooting up the bomber's own tail. The gunsight automatically compensated for the barbette's target lead, shell ballistics and parallax; all the gunner had to do was get the target into the crosshairs, track it and open fire at the right time.

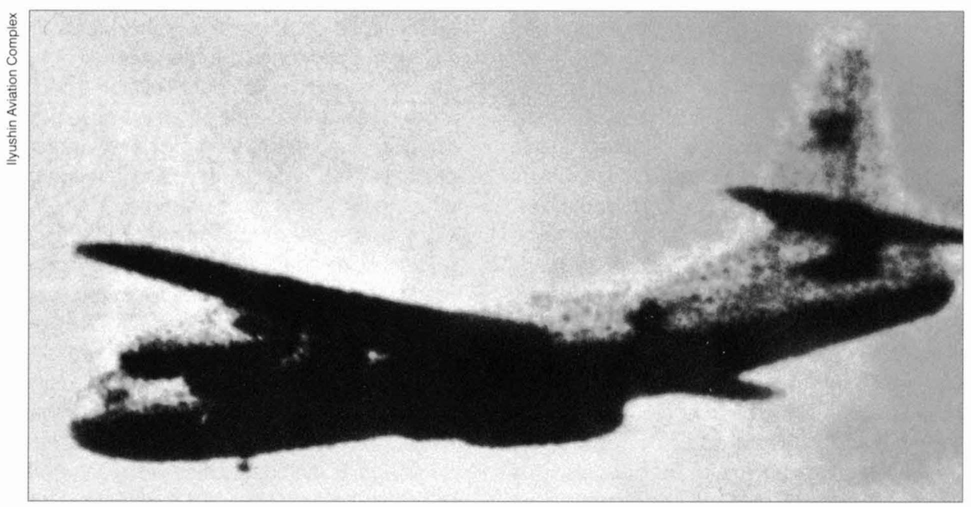
The remote control system made it possible to optimise the relative position of the gunner and his weapons so as to provide them with the best field of view and the biggest field of fire respectively. Placing them apart allowed the barbette to be made much more compact and consequently less draggy. Also, the remote control principle increased the defensive weapons' accuracy appreciably because, firstly, the cannons were more rigidly attached to their mounts; secondly, the gunsight did not vibrate due to the recoil and could track the target more smoothly; and, finally, the gunner was less susceptible to fatigue. On the other hand, the remote control system was fairly complicated and thus generated errors itself; these errors could be calculated and compensated for but were best reduced by keeping the control system simple.

A comparison of several defensive armament layouts showed that the remote control system really came into its own when the gunner and his weapons were placed at the aft extremity of the fuselage (that is, aft of the tail unit); in that case no 'blind spots' were created by the aircraft's structure and the system itself was comparatively simple and reliable. Realising the importance of creating a highly effective tail barbette and all that goes with it, Chief Designer Sergey V. Ilyushin took the decision to design the tail barbette in-house, despite the fact that defensive weapons systems were the domain of specialised design bureaux in the USSR.

Originally, in an effort to minimise the aircraft's drag, it was envisaged that the tail gunner would control his weapons from a prone position; yet this proposal was quickly rejected because it impaired the gunner's field of view, especially to the sides and upwards. In the definitive version of the tail gunner's station the gunner sat in the normal way and enjoyed an unrestricted field of view. This relative position of the gunner and the barbette was retained on nearly all Ilyushin aircraft featuring a tail gunner's station.

Designated IL-KU3 (*kormo**va**ya oosta**no**vka* – rear [defensive armament] installation), the barbette mounted an NS-23 cannon which traversed through ±70°, with a maximum elevation of 35° and a maximum depression of 30°. It was powered hydraulically by means of a hydraulic pump unit driven by a 1.7-kW electric motor and separate hydraulic rams for traversing and elevating. To facilitate aiming the tail gunner's seat could be raised and lowered by means of a separate electric motor.

On 31st January 1947 a special MAP expert panel signed its approval of the IL-22 ADP. Completion of the manufacturing drawings and prototype construction proceeded at a very brisk pace. From 28th to 29th June 1947 the completed prototype was trucked from Moscow-Khodynka to the flight test facility in Zhukovskiy where, after reassembly, preparations for the maiden flight began. The manufacturer's flight tests officially commenced on 19th July; five days later the aircraft became airborne for the first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This poor-quality but interesting shot shows the IL-22 in flight.

time, flown by captain Vladimir K. Kokkinaki, co-pilot Konstantin K. Kokkinaki and flight engineers M. G. Kirsanov and I. B. Küss. Yakov A. Kutepov was assigned to the programme as engineer in charge of the tests.

As already mentioned, with the specified take-off thrust the IL-22 was to have a normal TOW of 24 tons (52,910 lb). In reality, however, the TR-1 turbojets delivered only 1,300 kgp (2,865 lbst) for take-off instead of the required 1,500-1,600 kgp (3,300-3,530 lbst), forcing the take-off weight to be limited to 20 tons (44,100 lb) during the manufacturer's flight test stage. At 1.27-1.35 kg/kgp·hr (lb/lbst·hr), the engines' specific fuel consumption turned out to be rather higher than expected, too. The low thrust/weight ratio and high SFC adversely affected the aircraft's performance: the take-off run was 1,144 m (3,753 ft), the range turned out to be a mere 865 km (537 miles) and the endurance just 1 hour and 25 minutes. Top speed was 656.5 km/h (407.75 mph) at sea level and 718 km/h (446 mph) at 7,000 m (22,965 ft). In fairness, these figures basically met the manufacturer's estimates if one makes due corrections for the lower thrust and increased SFC; yet these figures could not satisfy anyone, of course.

The pilots' first impression of the IL-22 was unexpectedly favourable. Vladimir K. Kokkinaki reported that 'the aircraft is easy to fly and very responsive to control inputs. [The yaw caused by] throttling back one of the outer engines is easily countered by a slight deflection of the rudder and a turn of the control wheel and virtually does not cause an increase in control forces. The large volume of the fuselage makes itself felt during landings in a crosswind, but the sideslip is easily corrected by slight bank. The aircraft possesses excellent aerodynamics. The aircraft is underpowered, which has an effect on performance and handling, but this is easy to correct in the future.'

The test pilots further noted that, with two or four engines running, the aircraft had a smooth ride on the ground thanks to the good oleo struts and had excellent ground manoeuvrability. The take-off was extremely straightforward, if rather protracted due to the insufficient engine power. In level flight the bomber displayed no abnormalities, maintaining straight and level flight even with the controls released if properly trimmed. Flying the IL-22 was not tiresome.

In the event of a sudden engine failure, especially if the No.1 or No.4 engine was involved, the aircraft would yaw sharply in the direction of the dead engine, but normal flight could be restored with scarcely any extra pressure on the rudder pedals. The forces created by the thrust asymmetry were so slight that there was no need to adjust the rudder trim. Flying the aircraft with the Nos 1 and 4 engines shut down presented no problems either.

The landing approach was nothing out of the ordinary. After flareout the bomber created an air cushion due to the short-legged undercarriage, which eased the procedure considerably. The IL-22 showed no tendency to snake during the landing roll.

Yet the pilots also pointed out a number of shortcomings. In particular, the chosen forward fuselage design turned out to be unsatisfactory, the glazing framework obscuring large areas and the curved glazing panels creating annoying reflections and distorting the view. It turned out that, since the gunner's station was located well away from the barbette, some areas where the cannons could be brought to bear on the target were concealed from the gunner's view by the wings and fuselage.

It is worth noting that the twin-engined Tupolev Tu-12 (alias '77'), a heavily modified Second World War-vintage Tu-2 bomber refitted with Rolls-Royce Nene I centrifugal-flow turbojets and a tricycle landing gear, made its first flight almost concurrently with the IL-22. Still, the Ilyushin bomber was the first past the post.

On 18th August 1947 the IL-22 was demonstrated at the annual Aviation Day air parade at Moscow-Tushino. Until the end of September it made several more test flights (mainly for the purpose of assessing its performance, handling and powerplant operation).

Stage A of the manufacturer's flight tests ended on 22nd September 1947. After the original TR-1 engines, which had reached the limit of their service lives, had been replaced with a fresh shipset and minor changes made to the control system, Stage B of the manufacturer's flight tests began, continuing until 27th February 1948. It involved powerplant testing in low ambient temperatures, comparative evaluation of different types of barbette actuators and the like. In the opinion of the test crews, both of the barbettes' remote control systems (electric and hydraulic) served their purpose adequately; the electrically powered dorsal barbette was easy to aim and the inertia overshoots of the barbette when the gunsight was turned abruptly through large angles were small. The hydraulically powered tail barbette likewise required only small control forces; the controls were very sensitive and it took the gunner a while to adjust to them. The tail barbette's control system turned out to be more reliable than the electric actuators of the dorsal barbette.

Stage B included jet-assisted take-offs with the help of two SR-2 solid-fuel jet-assisted take-off (JATO) boosters attached to the rear fuselage sides; the boosters gave an initial impulse of 1,500 kgp (3,300 lbst) each. On 7th February 1948 Ilyushin OKB chief test pilot Vladimir K. Kokkinaki made the first-ever take-off with JATO boosters in the Soviet Union, flying the IL-22. Several such flights were made with varying take-off weights, demonstrating that field performance improved appreciably: the take-off run was reduced by 38% and the take-off distance to an altitude of 15 m (50 ft) by 28%. The test pilots stressed that operations with JATO boosters were simple and safe if the manual was observed, recommending that such boosters be used on other heavy jet aircraft as well.

Yet even at this stage the Lyul'ka OKB did not succeed in obtaining the required thrust from the TR-1 turbojet, which meant the bomber could not meet its performance target. Hence submitting the IL-22 for State acceptance trials was deemed inexpedient and the programme was terminated. For a while the aircraft was on display at the New Equipment Bureau (BNT – *Byuro* ***novoy tekh****niki*), a section of TsAGI, where prominent Soviet aviation industry specialists had a chance to examine it. The designation IL-22 was reused (albeit much later) for an airborne command post derivative of the IL-18D turboprop airliner (see Chapter 4).

IL-22 performance (manufacturer's flight test results)

Length overall	21.05 m (69 ft 0¾ in)
Wing span	23.06 m (75 ft 7⅞ in)
Wing area, m² (sq ft)	74.5 (801)
Normal take-off weight, kg (lb):	
target figure	24,000 (52,910)
actual	20,000 (44,100)
Empty weight, kg (lb)	14,950 (32,960)
Fuel load, kg (lb)	9,300 (20,500)
Bomb load, kg (lb):	
normal	2,000 (4,410)
maximum	3,000 (6,610)
Top speed, km/h (mph):	
at sea level	656.5 (407.75)
at 5,000 m (16,400 ft)	705 (437)
at 7,000 m (22,965 ft)	718 (446)
Landing speed, km/h (mph)	190 (118)
Time to altitude, minutes:	
to 5,000 m (16,400 ft)	8.6
to 8,000 m (26,246 ft)	17.4
Service ceiling, m (ft)	11,100 (36,420)
Range with a 2,000-kg bomb load at 4,900 m (16,080 ft) and a cruising speed of 485 km/h (301 mph)	865 (537)
Take-off run, m (ft)	1,144 (3,753)
Landing run, m (ft)	940 (3,080)
Defensive armament:	
20-mm cannons	2
23-mm cannons	2

IL-24 tactical bomber project (first use of designation)

On 26th June 1946, when the Ilyushin OKB was in the process of developing the IL-22 bomber, the Ministry of Aircraft Industry issued an order envisaging the development of a new bomber designated IL-24 and powered by two Mikulin TKRD-1 axial-flow turbojets; this engine (also designated AM-TKRD-1) was rated at 3,300 kgp (7,275 lbst) for take-off. Yet OKB-240 had more urgent business to complete first, and it was not until November 1946, when development of the IL-22 had been finished, that the OKB started PD studies on a new tactical bomber having a top speed of 900 km/h (559 mph) and a range of about 2,000 km (1,240 miles). Originally the IL-24 was effectively a re-engined IL-22 featuring reinforced defensive armament, with appropriate changes to the performance and weights; the airframe design and external dimensions were basically the same.

On 11th March 1947 the Council of Ministers passed a directive concerning the development of the IL-24 medium bomber powered by two AM-TKRD-1 turbojets; the aircraft was to commence State acceptance trials in September 1947. OKB-240 completed the project in the spring of that year; the aircraft retained the general arrangement of the IL-22. Apart from the engines, the IL-24 differed from its predecessor in featuring a new KU-4 twin-cannon tail barbette which was to improve its defensive capability appreciably.

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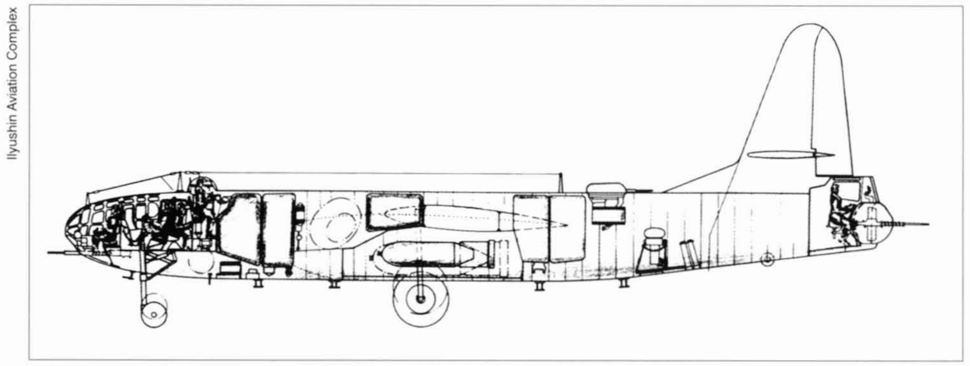

Above: A cutaway drawing of the IL-24 from the project documents.

Chief Designer Sergey V. Ilyushin endorsed the project on 16th May; on 30th May it received the go-ahead from an MAP expert panel. Yet the project was not destined to materialise in this form; MAP took the decision to divert the AM-TKRD-1 engines intended for the IL-24 to OKB-1 headed by Semyon M. Alekseyev where the '140' tactical bomber, whose development was officially commissioned by the ministry, was taking shape. The '140' (originally the Junkers EF 140) featured forward-swept wings and was developed under chief project engineer Brunolf W. Baade who, like many German aircraft designers, had been interned after the end of the Second World War and compelled to work for the USSR.

Meanwhile, the Rolls-Royce Nene I centrifugal-flow turbojet entered licence production in the Soviet Union as the RD-45; the licence-built version had a longer service life and a take-off thrust of 2,270 kgp (5,000 lbst). This was not enough for a twin-engined aircraft of the IL-24's size and weight, and the OKB had to rework the project to feature a powerplant consisting of four

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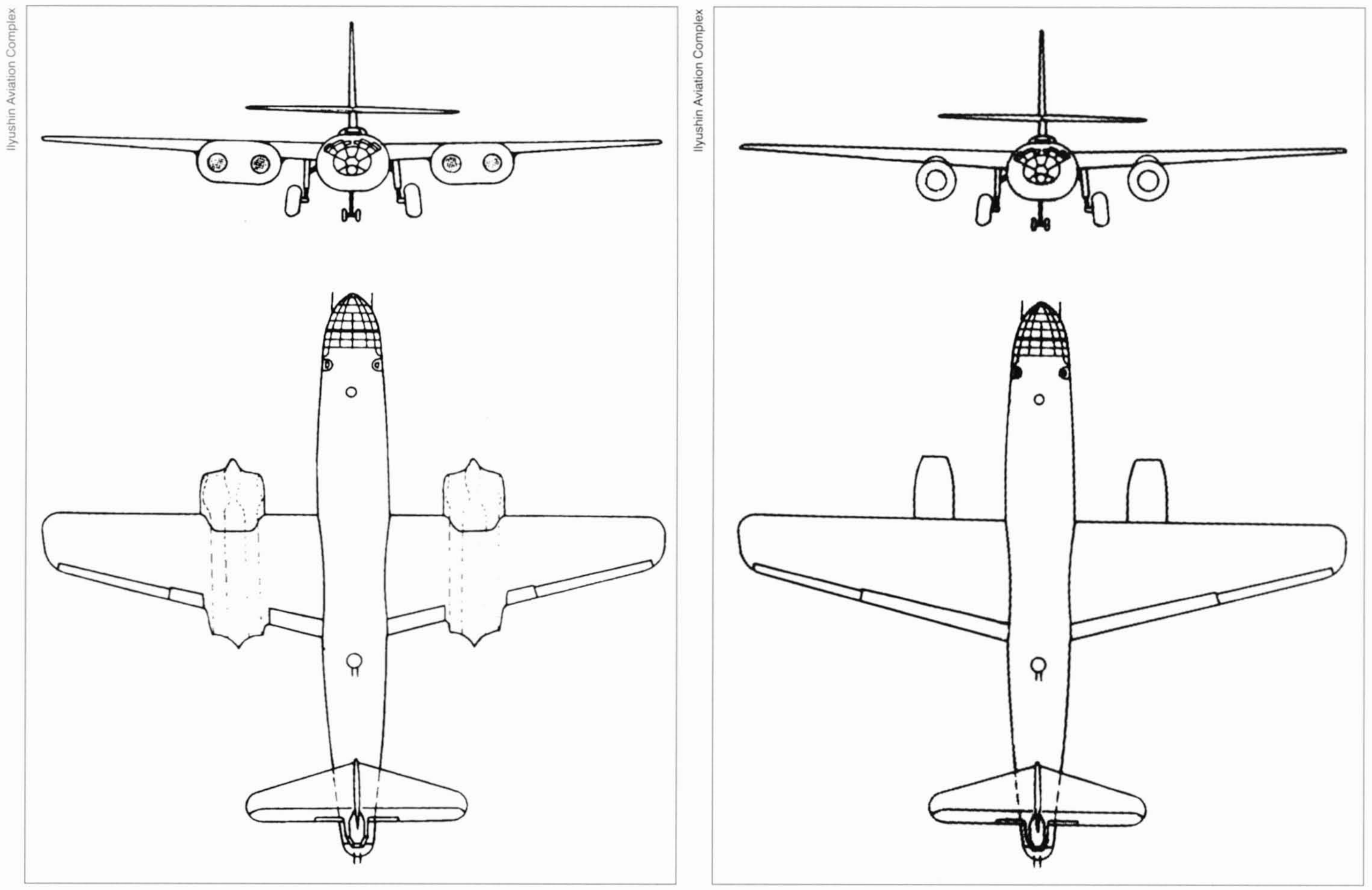


The IL-24 was projected with two alternative powerplants. The views on the left show the version powered by four Rolls-Royce Nene Is in paired nacelles; the version on the right is powered by two Mikulin AM-TKRD-1s.

RD-45s in paired nacelles. Yet, whatever engine type was used, the IL-24 was going to be very heavy; the RD-45-powered version grossed at 28 tons (61,730 lb), which made it unsuitable for operation from unpaved strips – and paved runways were still scarce in the USSR at the time.

All things considered, on 21st June 1948 the Council of Ministers issued a directive cancelling the IL-24 programme. By then the prototype was 65% complete.

After analysing the results of the IL-22's tests and the course of the IL-24's design work, Sergey V. Ilyushin resolutely (as was his wont) terminated all further work in this direction and embarked on a new tactical bomber project which eventually materialised as the highly successful IL-28. As for the IL-24 designation, it was again reused for a specialised long-range ice patrol derivative of the IL-18D (see Chapter 4).

IL-28 tactical bomber

The IL-28 project was conceived in late 1947. On 31st October that year Sergey V. Ilyushin wrote to the then-Minister of Aircraft Industry Nikolay A. Bulganin, proposing a tactical bomber powered by two Rolls-Royce Nene I turbojets, with a first flight date tentatively set for July 1948. This tight schedule was due in no small part to the experience accumulated with the IL-22, which would allow the new bomber to be developed quickly. The objective was to achieve a performance far superior to that of the IL-22 and the projected IL-24 bomber. This was made possible by reducing the crew and rethinking the defensive armament concept.

The IL-28's general arrangement was similar to its predecessor's. However, the aircraft was rather smaller and differed in a number of important respects. This was due to the new bomber's higher speed and different service conditions – unlike the IL-22, the IL-28 was designed to operate mainly from tactical airfields with unpaved strips.

The crew was reduced to three – pilot, navigator/bomb-aimer and tail gunner/radio operator. The decision to eliminate the co-pilot and the dorsal gunner was dictated first of all by the limited mission time of a tactical bomber. At a cruising speed of 650-750 km/h (403-465 mph) a sortie would typically last two or two and a half hours – four hours at the most. An autopilot would be installed to ease the pilot workload during cruise.

The armament would probably best be described now, as the IL-28 was, as one Russian writer put it, 'designed around the tail' – or, to be precise, the tail turret. As noted earlier, the trials of the IL-22 had shown that the remote-controlled dorsal barbette was inefficient because the tail unit created large blind sectors. Also, the widely spaced location of the dorsal gunner's station and the barbette meant that some areas where the cannon could be brought to bear on the target were concealed from the gunner's view by the wings and fuselage.

Various armament arrangements were studied. Eventually the engineers decided that a single tail turret offered adequate protection against enemy fighter attacks from the rear hemisphere, providing the cannons' traversing/elevating angles and speed were increased and the bomber made appropriate defensive manoeuvres. Also, the use of only a single tail turret reduced empty weight and improved aerodynamic efficiency.

Yet designing a new tail turret turned out to be quite a challenge; the engineers had to meet stringent specifications while keeping the unit's weight to a minimum. The IL-22's tail turret turned out to be too sluggish; a new power drive and remote control system had to be developed. The result was the highly efficient IL-K6 turret (once again, K stands for *kormovaya strelkovaya oostanovka* – tail barbette), originally mounting the same NS-23 cannon which were later replaced by Nudelman/Rikhter NR-23s with 225 rpg. The new weapons had the same calibre but a much higher rate of fire (850 rounds per minute versus 550 rpm for the earlier model).

The IL-K6 was the first Soviet electrohydraulically-powered remote-controlled turret; it had a traversing angle of ±70° and an elevation/depression angle of +60°/–40°. In normal mode the cannons moved at a rate of 15-17° per second, the motion increasing to up to 36° per second in boost (emergency) mode. The power drive enabled the turret to operate adequately at airspeeds in excess of 1,000 km/h (555 kts). At 340 kg (750 lb), the turret was relatively lightweight. By comparison, the turret used on the Tu-4 bomber (a reverse-engineered Boeing B-29) had traversing and elevating angles of only ±30° while weighing nearly 390 kg (860 lb).

The power drive of the IL-K6 turret was built around an unorthodox swivelling hydraulic pump unit driven by two 5-kW electric motors. The output of the pumps and hence the motion speed of the cannon depended on the angle at which the pump unit was tilted; with the pump unit in a neutral position the turret remained motionless. This made it possible to dispense with slide valves, reservoirs and other unreliable components, resulting in a simple and safe hydraulic system. The ammunition boxes were built into the body of the turret, allowing the customary belt feed and tightening mechanisms to be dispensed with, which again made for higher reliability.

The turret was electrically controlled by means of a highly reliable and precise potentiometric tracking system. Targeting was done by a computing gunsight which automatically made adjustments for the target's motion, shell velocity and trajectory, cannon traversing angle, flight altitude and airspeed. The sight received feedback from the turret to minimise miscoordination between the two. Thus, miscoordination in the horizontal plane was three times less than the limit set by general operational requirements of the time.

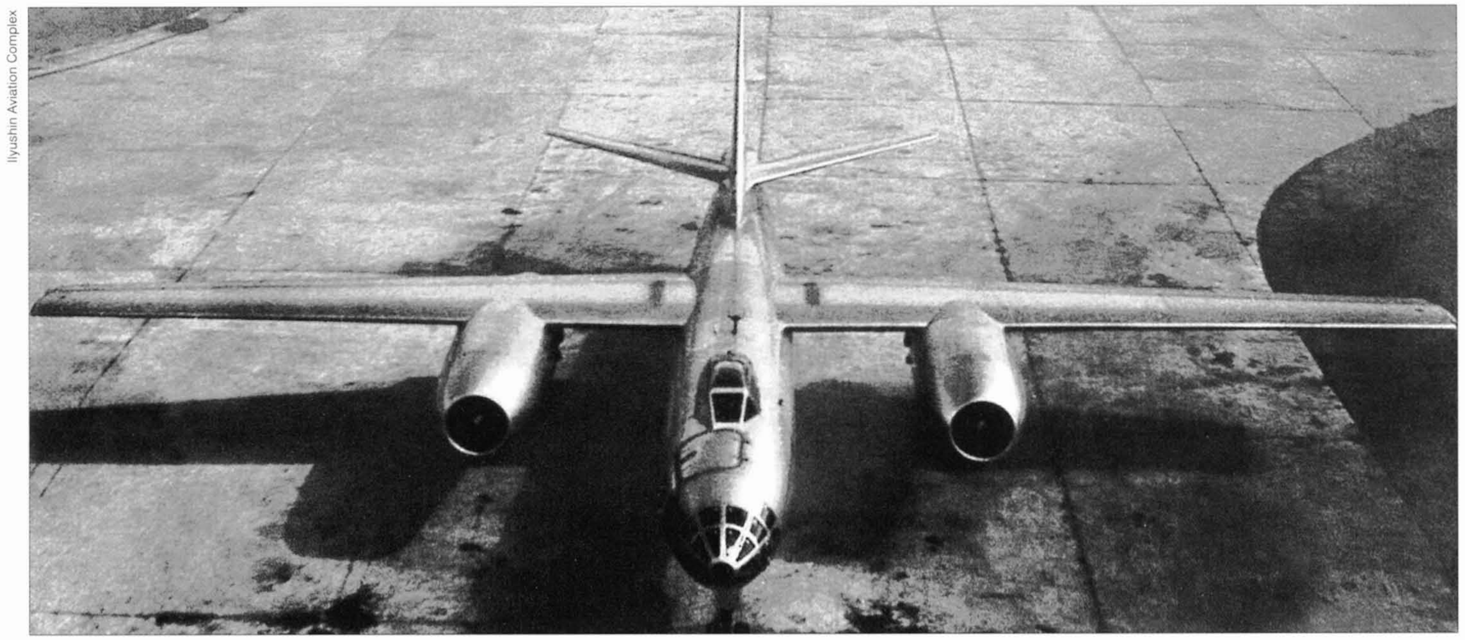
The IL-28 also featured two fixed forward-firing NR-23 cannons with 100 rpg installed on both sides of the nose on quick-release mounts. These were fired by the pilot and could be removed by simply disconnecting an electrical connector and turning a locking lever.

The decision to use only a single power turret and reduce the crew to three enabled the designers to make the IL-28's fuselage nearly 3.5 m (11 ft 5¾ in) shorter than that of the IL-22 and reduce wing area by 13.7 m² (147.3 sq ft), which led to a significant reduction in empty weight. Hence the second major difference was the powerplant. The basic projected size and weight allowed the new bomber to be powered by two RR Nenes rated at 2,270 kgp (5,000 lbst).

The Nene, which entered licence production in the USSR in 1947 as the Klimov RD-45 (RD = *reaktivnyy dvigatel'* – jet engine), had by then reached a high degree of reliability and boasted a 25-30% lower specific fuel consumption as compared to the TR-1. On the other hand, a major drawback of this engine was its large diameter caused by the centrifugal compressor. This, and the necessity to keep the air intakes as far away from the ground as possible in order to avoid foreign-object damage (FOD) – a must, since the aircraft was to operate from dirt airstrips, – led the designers to mount the engines in nacelles adhering directly to the lower surface of the wings (without pylons).

For CG reasons the engines were located well forward in the nacelles. Thus, the large diameter of the engine's compressor and the small jetpipe allowed the main gear units to be relocated from the fuselage to the engine nacelles, giving a wide track which was a bonus on semi-prepared strips. The shock struts were attached to the nacelles' main frames, and as they retracted forward the single mainwheels turned through 90° by means of simple mechanical links to lie flat in the bottom of the nacelles beneath the jetpipe (behind the combustion chambers).

To meet the high speed requirement the IL-28's wings employed a new TsAGI SR-5s high-speed airfoil developed under the guidance of Yakov M. Serebriyskiy and Maria V. Ryzhova – again with a 12% thickness-to-chord ratio. This enabled the bomber to reach a maximum speed of Mach 0.82 at 7,000-8,000 m (22,965-26,250 ft) without any adverse effects on stability and control characteristics caused by shock wave formation. The provision of simple slotted flaps assured the IL-28 good field performance.



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This view of the RR Nene-engined first prototype IL-28 shows that, unlike production examples, the engine nacelles were not area-ruled. Note also the angular cockpit windshield (another peculiarity of the first prototype) and the offset entry/ejection hatch of the navigator's station.

The high design speeds called for a swept tail unit which ensured good stability and handling throughout the speed range. The tail unit employed symmetrical sections with a slightly higher thickness-to-chord ratio than that of the IL-22. The fin was swept back 41° at quarter-chord while the stabilisers were swept back 30°; this delayed dangerous Mach buffet to a speed well above the aircraft's never-exceed speed.

As already mentioned, one of the complaints voiced by the IL-22's pilots during flight tests concerned the flightdeck glazing (which was blended entirely into the nose contour *à la* B-29). The curved glazing panels distorted the view and generated annoying reflections, and the heavy framework created numerous 'blind spots'. Since the IL-28 would be flown by a single pilot, the engineers provided him with a fighter-type cockpit enclosed by a sideways-opening bubble canopy with a bulletproof windscreen. The extensive nose glazing was still there of necessity, but now the navigator/bomb-aimer had the glazed nose all to himself.

The crew were seated in two pressurised compartments – one for the pilot and navigator/bomb-aimer, the other for the gunner/radio operator. At low altitudes these were pressurised by the slipstream; from 1,700 m (5,580 ft) and up the compartments were sealed off and pressurised by engine bleed air via filters. The pressurisation system was combined with the heating and ventilation systems. The cockpit and navigator's compartment were equipped with upward-firing ejection seats; ejection was triggered by jettisoning the canopy or entrance hatch respectively. The gunner bailed out via the ventral entrance hatch; the hatch cover doubled as a shield protecting him from the slipstream.

As had been the case with the IL-22, the IL-28's wing panels and tail surfaces had a manufacturing joint running along the chord line. Each half of the unit consisted of a number of panels incorporating stringers and ribs. This allowed different panels to be manufactured simultaneously at different workstations while improving the working conditions; noisy and labour-intensive manual riveting was replaced with high-quality machine riveting.

The fuselage was also designed in two halves with a manufacturing joint running the full length of it – it went together just like a plastic model kit! For the first time in Soviet aircraft production, all structural members of the fuselage were readily accessible, allowing riveting and assembly operations to be mechanised and various internal equipment to be fitted quickly and efficiently. The fuselage was also divided into four sections, facilitating the installation of equipment in bays which would not be accessible once the structure was fully assembled. Finally, the fuselage had longitudinal recesses on both sides covered by removable skin panels. These facilitated installation of all wiring and piping during manufacturing, as well as checking them and replacing faulty components in service. This feature reduced preflight check time and enhanced combat efficiency.

The slight weight penalty (about 4%) incurred by the new technology more than paid off. The surface finish was significantly improved; labour intensity was cut by 25-30% for production airframes and by 30-40% for internal equipment installation. As a result, the twinjet bomber was hardly more complicated to build than a tactical fighter. Also, this allowed Ilyushin to avoid a problem which affected some early Soviet jets – the propensity to uncommanded bank at high airspeeds. (This problem, which had manifested itself on the Mikoyan/Gurevich MiG-9 and MiG-15, was caused by aerodynamic asymmetry due to insufficiently high manufacturing accuracy.)

The Ilyushin OKB had accumulated a lot of design and operational experience with hot air de-icing systems and put it to good use when working on the IL-28. The turbojet engines powering the aircraft supplied lots of bleed air and enabled the engineers to quickly create the most efficient de-icing system of the time. This was the Soviet Union's first automatic hot air de-icing system; it was lightweight, reliable and simple to operate and had no parts disrupting the airflow. This feature greatly improved the bomber's combat efficiency and flight safety in adverse weather.

All-weather and night flying capability was ensured by the provision of a comprehensive avionics and communications suite enabling the crew to navigate the aircraft, detect, identify and destroy ground targets without maintaining visual contact with the ground. The avionics suite included an

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Above and left: Two more aspects of the first prototype IL-28, showing such peculiarities as the elaborate cockpit canopy framework, the dorsal ILS aerial, the location of the PSBN-M navigation/attack radar in a retractable radome in line with the fin leading edge and the ventral strake under the tail gunner's station. The position of the radome would change and the strake was found to be superfluous.

OSP-48 instrument landing system (ILS) for use in instrument meteorological conditions (IMC). The ground part of the system included two range beacons, three marker beacons, communications radios and an HF or VHF radio direction finder to facilitate approach and landing in bad weather. The system's components installed on the aircraft comprised an ARK-5 Amur (a river in the Soviet Far East; pronounced like the French word *amour*) automatic direction finder, an RV-2 *Kri**stall*** (Crystal) low-altitude radio altimeter and an MRP-48 Dyatel (Woodpecker) marker beacon receiver. (OSP = *obo**roo**dovaniye sle**poy** po**sah**dki* – blind landing equipment; ARK = *avtoma**tich**eskiy* ***rah**dio**kom**pas* – ADF; RV = ***rah**diovyso-**to**mer* – radio altimeter; MRP = ***mar**kernyy* ***rah**dio**pree**yomnik*. The MRP-48 has also been called *Khrizan**tema*** (Chrysanthemum) in some sources.) The OSP-48 was fairly simple and had few components, which rendered the ground part suitable for use on tactical airfields (in truck-mounted form). The aircraft was also equipped with an AP-5 electric autopilot and an IFF transponder.

Unlike the IL-22, the IL-28's normal bomb load was 1,000 kg (2,205 lb); the maximum bomb load in overload condition remained the same at 3,000 kg (6,610 lb). The bomb bay located in the centre fuselage featured four bomb cassettes and one beam-type bomb cradle. The former could carry bombs of 50-500-kg (110-1,102-lb) calibre while the latter was designed for bombs weighing from 1,000 to 3,000 kg.

In visual meteorological conditions (VMC) the navigator/bomb aimer used an OPB-5S optical bomb sight (*op**tich**eskiy pri**tsel** bombardi**rov**ochnyy*) which enabled him to take aim automatically at stationary and moving targets in level flight. The OPB-5S computed the sighting angles and dropped the bombs automatically at the proper moment by means of an electric release mechanism. The sight was gyrostabilised to prevent the aircraft's manoeuvres from affecting bombing accuracy and linked to the autopilot, enabling the navigator to set the aircraft's course on its bombing run. In IMC, bomb-aiming was assisted by the PSBN-M search/bomb-aiming radar (*pri**bor** sle**po**vo bombome**tah**niya i navi**gah**tsiï* – blind-bombing and navigation device) with a 360° field of view. The radar was initially located in the aft fuselage in line with the fin leading edge and enclosed by a dielectric fairing, retracting flush with the fuselage underside when not in use.

IL-28 – first prototype powered by Rolls-Royce Nene engines

General Designer Sergey V. Ilyushin approved the IL-28's advanced development project on 12th January 1948, giving the go-ahead to issue a set of manufacturing drawings and start prototype construction. By then, however, Tupolev's OKB-156 – the Soviet Union's leading authority in bomber design – had received an assignment to develop and build a similar jet-powered tactical bomber. OKB-240 had no such assignment. Still, Ilyushin's belief in his aircraft was so strong that he decided to carry on with the IL-28 and build a prototype at his own risk – all the more so because the Soviet Air Force was in desperate need of a tactical bomber meeting the stringent new requirements. The IL-28 was not officially included into the Ministry of Aircraft Industry's experimental aircraft construction plan until 12th June 1948 when the Soviet Council of Ministers issued directive No.2052-804 to this effect – one month before the first prototype was rolled out.

Powered by authentic Rolls-Royce Nene turbojets imported from the UK, the prototype commenced ground tests at the OKB's experimental shop at Moscow-Khodynka on 29th May 1948. On 1st July the aircraft was dismantled and trucked to the LII airfield in Zhukovskiy where it was to undergo flight tests. V. N. Boogaiskiy was appointed engineer in charge of the flight tests.

The company chief was as good as his word: the bomber took to the air for the first time on 8th July 1948 with Ilyushin OKB chief test pilot Vladimir K. Kokkinaki at the controls. Kokkinaki was pleased with the aircraft's handling, saying that the IL-28 was easy to fly both during take-off and in cruise and climbed well.

The IL-28 had good directional and lateral stability throughout its operational envelope. When properly trimmed the aircraft flew stably in level flight even when the controls were released. Low-speed handling was quite good, with no tendency to stall or spin. Straight and level flight with one dead engine was no problem either, the yaw being easily countered without excessive loads on the rudder pedals.

The aircraft had good field performance and could operate from existing airbases and tactical airfields. At a normal gross weight of 17,220 kg (37,960 lb) the take-off run was just 560 m (1,840 ft) if the aircraft was fitted with two PSR-1500-15 JATO rockets (PSR = *porokho**vaya** **star**tovaya ra**keta*** – solid-fuel rocket booster) with a 13-second burn time developing 1,600 kgp (3,530 lbst) each. The IL-28 could easily operate from dirt strips.

During manufacturer's flight tests the Nene-powered first prototype attained a top speed of 833 km/h (517 mph) at 5,000 m (16,400 ft) and reached Mach 0.79 at 7,000-8,000 m (22,965-26,250 ft). The test pilots reported that the aircraft behaved normally at these speeds and could go even faster if appropriate changes were made. Hence the OKB set about streamlining the airframe and installing more powerful engines.

Tupolev's competing trijet bomber prototypes bearing the in-house designations '73' and '78' (the former was powered by two RR Nene Is in wing-mounted nacelles and one RR Derwent V in the rear fuselage; on the otherwise identical '78' these were replaced by the licence-built versions – two RD-45Fs and one RD-500) were undergoing manufacturer's flight tests at the same time. On their jet bombers the Tupolev engineers had copied the defensive weapons arrangement of the piston-engined Tu-2, which led to excessively large overall dimensions, an overly large crew and hence excessive weight, not to mention the decidedly complex powerplant. When he first laid eyes on the IL-28, Andrey N. Tupolev scornfully asked whose *bastard child* it was. Yet the Ilyushin bomber's defensive armament arrangement gave him some food for thought. As a result, the ultimate '81' (Tu-14) bomber and '89' (Tu-14T) torpedo-bomber dispensed with the centre engine and two remote-controlled gun barbettes in favour of a single tail gunner's station, as on the IL-28.

IL-28 – second prototype powered by RD-45F engines

On 30th December 1948 the second prototype IL-28 powered by production RD-45F engines (F = *for**seer**ovannyy* – in this instance, merely uprated but not afterburning) entered flight test, again flown by Vladimir Kokkinaki. New models of tyres were tested concurrently with the aircraft itself, as the original ones were totally worn out after just ten landings on concrete strips. The best results were attained with tyres made of perlone, a synthetic rubber, which lasted for more than 100 landings.

Apart from the powerplant, the second prototype differed from future production IL-28s in avionics and equipment fit. The aircraft was equipped with RSB-5 and RSU-10 radios, an SPUF-3 intercom, an MRP-46 marker beacon receiver, AFA-BA and AFA-33/50 or AFA-33/75 aerial cameras, two GSN-3000 generators, three sets of KP-14 breathing apparatus with 8-litre (1.76 Imp gal) liquid oxygen bottles, an RUSP-48 ILS and the like (AFA = ***aero**fotoappa**raht*** – aircraft camera; KP = *kislo**rod**nyy pree**bor*** – oxygen equipment.)

After the successful completion of the initial flight test programme the second prototype was turned over to GK NII VVS for State acceptance trials which lasted from February to April 1949. The formal Act of acceptance was signed on 18th May.

The specifications of the RD-45F-powered second prototype IL-28 attained at the State acceptance trials are detailed in the table on this page.

The Tu-14 was undergoing trials concurrently. The Powers That Be were to choose between the two, so that in effect Ilyushin and Tupolev had a flyoff, even though the term was unknown in the Soviet Union at the time. Hence the Soviet Air Force top brass was in a turmoil; some of the generals and marshals lobbied for the Tu-14 which had somewhat longer range, while other supported the IL-28 which was much easier to build and operate. The discussion raged on at the ministerial level; the chief of NII VVS denounced the IL-28 and strongly urged Minister of Aircraft Industry Nikolay A. Bulganin to give the go-ahead for the Tu-14. Still, even Bulganin failed to resolve the issue.

Specifications of the second prototype IL-28

Length overall	17.45 m (57 ft 3 in)
Height on ground	6.0 m (19 ft 8¼ in)
Wing span	21.45 m (70 ft 4½ in)
Wing area	60.8 m² (653.76 sq ft)
Wing loading	288 kg/m² (1,400 lb/sq ft)
Power loading at sea level	3.38 kg/kgp (lb/lbst)
Normal all-up weight	17,500 kg (38,580 lb)
Maximum all-up weight	20,000 kg (44,090 lb)
Fuel load	6,300 kg (13,890 lb)
Top speed:	
at sea level	750 km/h (465 mph)*
at 5,750-6,000 m (18,860-19,685 ft)	843 km/h (523 mph)
at 10,000 m (32,808 ft)	820 km/h (509 mph)
Landing speed	178 km/h (110.5 mph)
Rate of climb:	
at sea level	10.9 m/sec (2,145 ft/min)
at 5,000 m (16,400 ft)	8.3 m/sec (1,633 ft/min)
at 10,000 m (32,810 ft)	3.6 m/sec (708 ft/min)
Time to height:	
to 5,000 m	8.6 min
to 10,000 m	22.6 min
Range:	
at 20,000 kg TOW, 5,000 m and 542 km/h (336 mph)	1,815 km (1,127 mi.)
at 20,000 kg TOW, 10,000 m and 546 km/h (339 mph)	2,370 km (1,472 mi.)
Endurance at 10,000 m cruising altitude and 546 km/h cruising speed	4 hrs 13 min
Take-off run	1,150 m (3,770 ft)/ 650 m (2,130 ft)†
Take-off distance	2,540 m (8,330 ft)/ 990 m (3,250 ft)†
Landing distance	1,730 m (5,680 ft)‡

Notes:
* Speed limited at altitudes up to 1,750 m (5,740 ft) due to 2,700 kg/m² (13,122 lb/sq ft) dynamic pressure limit.
† Without boosters/with two PSR-1500-15 JATO bottles.
‡ With a 13,500-kg (29,760-lb) landing weight.

Finally, on 14th May 1949 a special commission chaired by Iosif V. Stalin himself analysed the test results and compared the performance of the two types. According to Ilyushin, after examining the reports carefully and listening to his military advisors Stalin picked the IL-28. However, Ilyushin was requested to increase the maximum speed of production aircraft to 900 km/h (559 mph) as soon as possible by re-engining the IL-28 with more powerful and fuel-efficient Klimov VK-1 turbojets; Council of Ministers directive No.1890-700 to this effect appeared on the same day. The VK-1 was a version of the RD-45F uprated to 2,700 kgp (5,950 lbst). As a 'consolation prize', Tupolev was requested to develop a version of the Tu-14 (likewise powered by VK-1s) for the Naval Air Arm.

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Top, centre and above: Three views of a pre-production VK-1-engined IL-28. These views illustrate the area-ruled engine nacelles, the relocated radar enclosed by a teardrop radome and the revised canopy design, as well as the sleek lines of the bomber.

IL-28 production version powered by VK-1 engines

Building on the results of numerous wind tunnel tests at TsAGI, the Ilyushin OKB developed new engine nacelles for the production VK-1-powered form of the IL-28. Unlike the prototypes' nacelles which were bulged around the middle, the new ones were distinctly area-ruled, the 'waist' being narrowest where the wing section was at its thickest. This significantly reduced harmful interference between the wings and the nacelles, especially at transonic speeds, resulting in a major improvement in the IL-28's performance.

Other changes were made after the initial flight tests and State acceptance trials. The PSBN-M radar was relocated from the aft fuselage to a position immediately aft of the nosewheel well in order to improve its operating conditions and enclosed by a teardrop-shaped radome. The rudder's horn balance was enlarged to reduce rudder forces. Some minor changes were made to the hydraulic system and the nosewheel steering actuator/shimmy damper. The fuselage fuel cells were equipped with a nitrogen pressurisation system to reduce the danger of explosion if hit by enemy fire, enhancing survivability. The angular cockpit windscreen of the prototypes gave way to a more streamlined one featuring an elliptical Triplex windshield and curved sidelights, and the frame of the hinged canopy portion was simplified by introducing a two-piece blown transparency. The navigator's glazing was also modified.

The pre-production IL-28 powered by VK-1s commenced flight tests on 8th August 1949; the crew was the same as on the day of the type's maiden flight a year earlier. At a normal gross weight of 18,400 kg (40,560 lb) the aircraft had a top speed of 906 km/h (562 mph) at 4,000 m (13,120 ft). The pilots noted that the aircraft was stable at any speed; control forces could be trimmed down easily. At the maximum allowed speed of Mach 0.78 the back pressure on the control column gradually increased; then, if elevator trim remained unchanged, the load reversed, the control column would move forwards and the aircraft would tend to go into a dive. If elevator trim was selected up the aircraft could reach Mach 0.81-0.82, but this caused severe Mach buffet, warning the pilot to slow down.

With a 1,000-kg (2,204-lb) normal bomb load and a 21,000-kg (46,296-lb) MTOW the IL-28 had a maximum range of 2,455 km (1,525 miles) and was generally superior in performance to the piston-engined Tu-2 which was the mainstay of the VVS's tactical bomber force at the time.

On 24th August 1949 the production-standard VK-1 powered aircraft was handed over for State acceptance trials and passed them with flying colours. On 16th September the State commission recommended that production be started forthwith, and so it was. Starting in September 1949, three major aircraft factories – No.30 *'**Zna**mya **trooda**'* (Banner of Labour) at Khodynka airfield right in the centre of Moscow, No.64 in Voronezh and No.166 in Omsk – started gearing up to build the IL-28. A fourth factory, No.39 in Irkutsk, also launched IL-28 production shortly afterwards. (Some sources state the IL-28 was also built by plants No.1, No.18 (both in Kuibyshev, now Samara) and No.23 in Fili, but this appears highly unlikely).

After the type's first public appearance at the 1950 May Day parade in Moscow the NATO's Air Standards Co-ordinating Committee (ASCC) initially allocated the codename *Butcher* to the IL-28. However, this was promptly changed to *Beagle* to avoid confusion with the Tupolev Tu-16 medium bomber which was code-named *Badger*.

The basic bomber version was built in Moscow, Voronezh and Omsk; the first production aircraft left the Moscow production line in March 1950. The aircraft was built in huge numbers (no fewer than 6,316 copies of all versions were built in the USSR alone in 1950-55!), becoming one of the most prolific types in service with the VVS..

Various improvements were introduced in the course of production. Among other things, the IL-28 received more effective formation lights for station-keeping during flights of bomber formations at night. The cockpit windshield received an electric de-icing system, and hot air de-icing was introduced on the engine air intake leading edges. Optically flat windshield sidelights were tested (probably on an uncoded example with the c/n 52005714 – that is, izdeliye (product) 5, denoting the basic bomber version, year of manufacture [195]2, plant No.[3]0, Batch 057, 14th aircraft in the batch) in an effort to reduce distortions and improve cockpit visibility, but this feature was not fitted to standard production aircraft.

Four shutoff valves were introduced in the fuel system to seal off a punctured tank in the event of battle damage, preventing loss of fuel (eventually the Beagle was given self-sealing fuel tanks which theoretically took care of the problem). Fuel cell No.3 was divided into cells Nos 3A and 3B; the capacity of these cells was carefully calculated in order to preserve the CG position as the fuel was burned off, obviating the need for fuel transfer.

(Note: Some sources claimed that the CG shift problem associated with fuel burnoff still was there and was, in fact, the IL-28's only major shortcoming which was never eliminated due to the lack of an automatic fuel transfer system maintaining CG position. Since the forward fuel cells accommodated more fuel than the rear fuel cells, the IL-28's CG gradually shifted forwards. This was especially unwelcome during landing; the pilot had to keep an eye on the fuel meters and activate the fuel transfer pump at the right moment. The pump worked slowly, and as the pilot had to concentrate on flying the aircraft during the landing approach he often forgot to turn it off in time. As a result, the CG would now be too far aft and the aircraft assumed an excessively nose-high attitude, with high angles of attack which were difficult to counter by elevator input. To make up for the missing system, IL-28 pilots would ask the navigators to remind them to switch off the pump in time.)

New ejection seats were fitted; unlike the earlier model, they featured leg restraints, a face protection visor and a seat belt tightening mechanism. Finally, a brake parachute was provided to shorten the landing run; this feature was tested on IL-28 c/n 2007 pursuant to an MAP order of 11th January 1951. (Only the batch number and number of aircraft in the batch were stated in MAP documents; however, considering the date, the aircraft was probably built at MMZ No.30 in 1950 and the full c/n must be 50302007.) However, everything comes at a price, and these modifications were expected to increase empty weight by 240 kg (530 lb). Hence Ilyushin engineers took measures to achieve an identical weight reduction, lightening the rear fuselage structure, tail unit and IL-K6 turret, removing the anti-flutter weights from the wings and so on. Additionally, air bleed valves were incorporated into the engine nacelles to prevent engine surge, and the OSP-48 ILS was replaced by a more advanced SP-50 ***Materik*** (Continent) ILS.

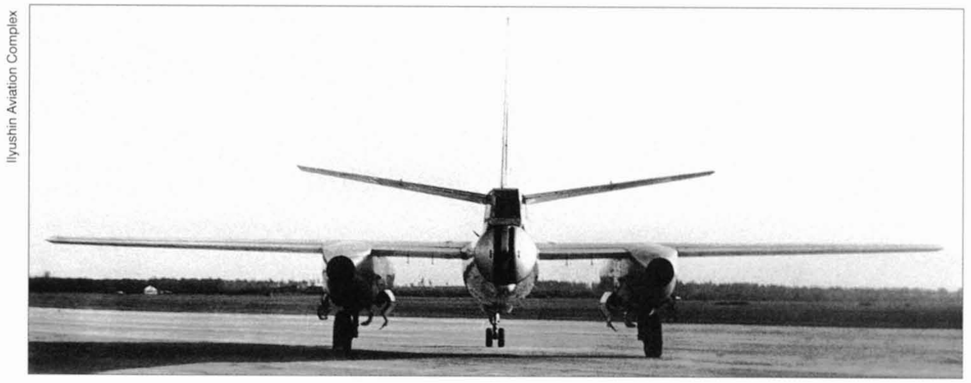
For the development of the IL-28 bomber Sergey V. Ilyushin, M. F. Astakhov, Valeriy A. Borog, V. N. Boogaiskiy, N. F. Zotov, A. Ya. Levin, G. M. Litvinovich, M. I. Nikitin, B. V. Pavlovskiy, K. V. Rogov, Ye. I. Sankov and V. A. Fyodorov were awarded the prestigious Stalin Prize (2nd Class) on 12th March 1951 *'for outstanding inventions and improvements in the field of machinery design'*.

The basic bomber soon evolved into a range of specialised versions which expanded the *Beagle*'s combat potential perceptibly.

IL-28U *Mascot* trainer

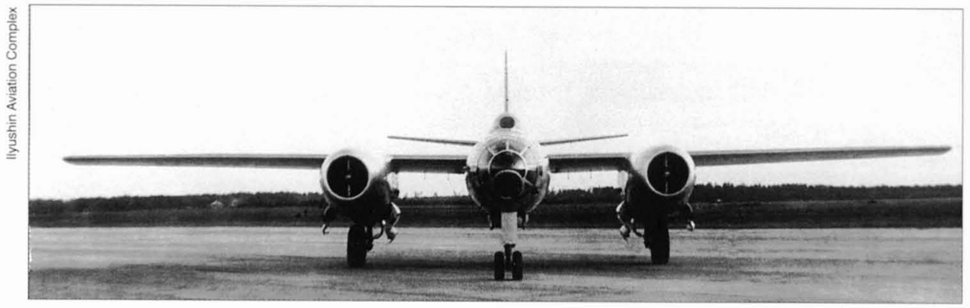
Specialised versions began appearing before long. Predictably, the first of these was a conversion trainer easing the transition from piston-engined types to the jet bomber. The OKB was immediately tasked with creating such an aircraft; development began in September 1949, and on 14th October Sergey V. Ilyushin approved the advanced development project of the IL-28U trainer (*oo**cheb**nyy* – training, used attributively) powered by VK-1 engines.

The IL-28U (erroneously called UIL-28 in some sources) differed from the basic bomber primarily in having a new nose



Ilyushin Aviation Complex

Above: Rear view of a production-standard IL-28.



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Above: Front view of a production-standard IL-28.

Yefim Gordon archive

Maintenance day at an IL-28 unit. The second aircraft in the row, '12 Blue' (c/n 3402209 – ie, year of production 1953, plant No.64, Batch 22, ninth aircraft), is having its tail cannon cleaned. Note the open gunner's hatch.

Russian Central National Economy Archive

Above: The unserialled prototype of the IL-28U during Soviet Air Force evaluation in the early 1950s.

Yefim Gordon archive

Above: This shot of a production IL-28U coded '99 Red' taxying out for take-off clearly illustrates the characteristic forward fuselage design with the stepped windscreen of the instructor's cockpit.

Yefim Gordon archive

A production IL-28U coded '85 Blue' comes in to land. The trainer version was manufactured exclusively by the Moscow factory.

grafted on in place of the extensively glazed navigator's station (up to fuselage frame No.6). It incorporated the instructor's cockpit with a stepped windscreen, rather like the flightdeck of an airliner *en miniature*; the trainee pilot sat in the standard cockpit. The result certainly looked bizarre but both the trainee and the instructor enjoyed an unrestricted field of view.

The trainee's cockpit was virtually identical to that of the standard bomber, except for a cutout in the instrument panel permitting visual contact with the instructor, which required some of the flight instruments to be relocated. The forward cockpit featured a complete set of flight controls and instruments; the instructor had complete control over the trainee's actions and could take over if necessary by flipping some switches, barring the trainee from flying the aircraft.

All armament and bomb aiming equipment, including the radar, were deleted. Still, the IL-28U could be used for training gunners/radio operators, for which the former gunner's station was suitably equipped. The fuel capacity was reduced to 6,600 litres (1,452 Imp gal) and the fuel load to 5,500 kg (12,125 lb). To maintain CG position the tail turret was substituted by 250 kg (551 lb) of ballast on the prototype. According to calculations, production aircraft were to have 200 kg (440 lb) of ballast but it was found possible to reduce this to 130 kg (286 lb).

Other changes included removal of the RV-10 radio altimeter and the fuel tank inert gas pressurisation system. The IL-28U was equipped with an RSIU-3B radio (instead of the bomber's RSU-5), an AP-5 autopilot, a Bariy-M (Barium-M) IFF transponder, an SPU-5 intercom, an RV-2 radio altimeter and a Materik-B ILS with SD-1 distance measuring equipment.

On 21st February 1950 a *Beagle* was delivered to the OKB's experimental shop (MMZ No.240 'Strela' (Arrow)) at Moscow-Khodynka straight off the MMZ No.30 production line for conversion into the IL-28U prototype. Piloted by Vladimir K. Kokkinaki, the trainer took to the air on 18th March, with B. A. Goloobev as flight engineer and B. A. Yerofeyev as radio operator; A. P. Vinogradov was engineer in charge of the tests.

It was soon discovered that performance and handling were virtually identical to that of the standard bomber, except for the marginally better climb rate. The IL-28U was stable throughout its flight envelope, remaining well balanced at Mach 0.78. It performed all manoeuvres the bomber version was to make; turns with 70-80° bank could be made without any trouble and the aircraft gained 2,000 m (6,560 ft) during a yo-yo manoeuvre. Flying the aircraft from the instructor's seat was just as simple and enjoyable as from the rear cockpit. Like the other versions, the trainer could be fitted with PSR-1500-15 JATO boosters.

The manufacturer's flight test programme was completed on 30th March 1950. By then a bomber regiment commanded by Lt. Col. A. A. Anpilov, Hero of the Soviet Union, was taking delivery of production IL-28 bombers. Therefore it was decided to hand over the IL-28U prototype to that unit for evaluation in order to speed up conversion training. This enabled Anpilov's unit to achieve initial operational capability in time for the 1950 May Day parade in Moscow (which of course was largely a matter of prestige); the trainer prototype took part in this parade together with production *Beagles*. Then the IL-28U was turned over to NII VVS for State acceptance trials which took place from 13th to 27th May 1950; the trials protocol was signed by Soviet Air Force C-in-C Air Marshal Pavel F. Zhigarev on 8th June.

The type entered large-scale production at MMZ No.30 pursuant to an MAP order of 21st July 1950 (all IL-28Us were built in Moscow) and remained the principal trainer for Soviet and Warsaw Pact tactical bomber pilots well into the 1970s. Soviet trainers were assigned NATO codenames in the 'miscellaneous aircraft' category at the time – a practice later discontinued; accordingly the IL-28U was code-named *Mascot*. On production IL-28Us the empty operating weight rose to 11,900 kg (26,230 lb) and the all-up weight to 17,700 kg (39,020 lb), reduction in ballast notwithstanding.

The transition from the IL-28U to the bomber version did not require additional training. The report of the State commission said that a pilot with 350-400 hours' total time on anything from the Polikarpov Po-2 *ab initio* trainer to the Tu-2 bomber could fly the IL-28 solo after only two to four flights on the trainer version. The Naval Air Arm (AVMF – *Aviahtsiya voyenno-morskovo flota*) also operated the *Mascot*; the first naval aviation unit to receive the IL-28U in October 1951 was the 943rd MTAP (***minno-torpednyy aviapolk*** – Minelaying and Torpedo-Bomber Regiment).

IL-28U ejection trainer version

On 10th December 1953 MAP issued an order concerning the development of a version of the IL-28U specially modified for training *Beagle* crews in ejection techniques. This aircraft's *raison d'être* was that the crews were apprehensive about the bomber's first-generation ejection seat, fearing serious injuries in the event of an ejection at low altitude or on landing when most accidents happen. It was necessary to overcome this psychological obstacle and build up the pilots' confidence in the aircraft.

The Ilyushin OKB delivered a set of manufacturing documents for the ejection trainer to MMZ No.30 on 5th March 1954. Unfortunately it is not known how many *Mascots*, if any, were built in this configuration.

IL-28R tactical reconnaissance aircraft

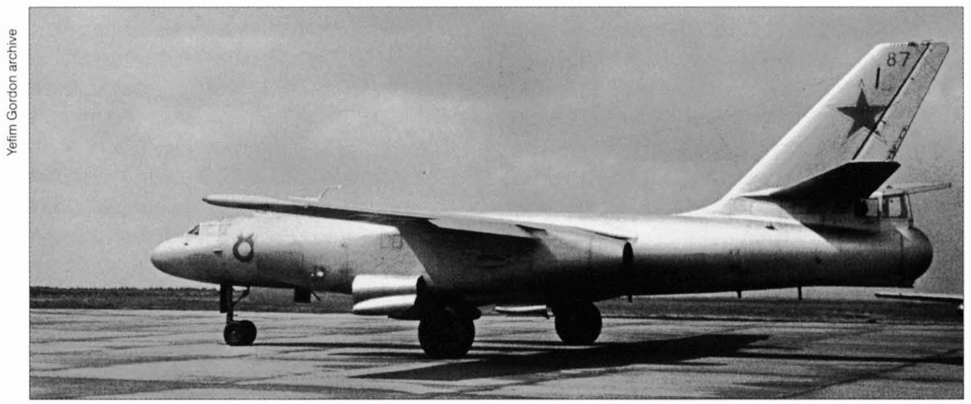
On 5th March 1950 a Moscow-built IL-28 was delivered to MMZ No.240 for conversion into the prototype of the IL-28R ([*samolyot-*] *razvedchik*) reconnaissance aircraft. The unserialled aircraft entered flight test on 19th April 1950, one month and one day after the first flight of the IL-28U, flown by pilot Vladimir K. Kokkinaki, flight engineer I. B. Küss and radio operator B. A. Yerofeyev. Once again A. P. Vinogradov was in charge of the flight tests.

The IL-28R was intended for tactical photo reconnaissance (PHOTINT) to meet the objectives of fronts (in a war scenario), fleets and air armies. For day reconnaissance the aircraft could carry a PHOTINT suite comprising two AFA-33/100 or AFA-33/75 cameras on AKAFU tilting mounts in the forward and centre parts of the (former) bomb bay for high/medium-altitude photography, one AFA-33/20 or AFA-42/20 (AFA-RB/20) downward-looking camera in the rear part of the bomb bay and one AFA-33/50 or AFA-33/75 camera mounted obliquely on the port side in a special camera bay in the aft fuselage. Alternatively, some aircraft were fitted with two AFA-42/100 or AFA-42/75 cameras on the forward mount.

For night sorties the IL-28R carried two NAFA-3S/50 cameras or one NAFA-MK-75 (or NAFA-MK-50) camera in the forward part of the bomb bay. The rest of the bay was occupied by twelve 50-kg (110-lb) FotAB-50-35 flare bombs; this number was reduced to six if a long-range fuel tank was fitted. (NAFA = *nochnoy aerofotoapparaht* – aircraft camera for night operations; AKAFU = *avtomaticheskaya kachayushchayasya aerofotoustanovka* – automatic tilting mount for aircraft cameras; FotAB = *fotograficheskaya aviabomba* – lit. 'photo bomb' (that is, flare bomb for aerial photography.) The bombs were dropped using an NKPB-7 bomb sight which could be used at up to 11,500 m (37,730 ft). One Russian source, however, gives rather different data: three AFA-33 cameras with varying focal lengths (100, 75 and 20 cm; 39⅜, 29½ and 7⅞ in) and one AFA-RB camera for day sorties and two NAFA-3S cameras for night sorties, assisted by FotAB-100-60, FotAB-50-35, SAB-100-55 or SAB-100-35 flare bombs (SAB = *svetyashchaya aviabomba* – flare bomb). The cameras were installed in special containers heated by air from the cockpit heating and pressurisation system to prevent the lubricant from freezing at high altitude; the night cameras, however, did not have such containers.

To extend range the capacity of the fuel system was increased to 9,550 litres/8,000 kg (2,101 Imp gal/17,640 lb). This was done by installing a 750-litre (165 Imp gal) long-range tank in the aft portion of the bomb bay, which required the standard No.3 fuel cell to be removed, and two 950-litre (209 Imp gal) drop tanks at the wingtips. As compared to the standard bomber, this amounted to 1,650 litres (363 Imp gal) of additional fuel. (Some sources quoted a figure of 2,660 litres (585.2 Imp gal) of additional fuel. Also, some documents state that the additional fuselage tank held 760 litres (167.2 Imp gal), making for a total internal fuel volume of 9,560 litres (2,103.2 Imp gal), and the drop tanks each held 900 litres (198 Imp gal).) The increased mission time (up to five hours) necessitated the provision of additional oxygen for the crew.

Depending on the equipment fit the reconnaissance version's MTOW was 22,685-22,720 kg (50,010-50,090 lb). Therefore the main landing gear units were reinforced and fitted with bigger wheels measuring



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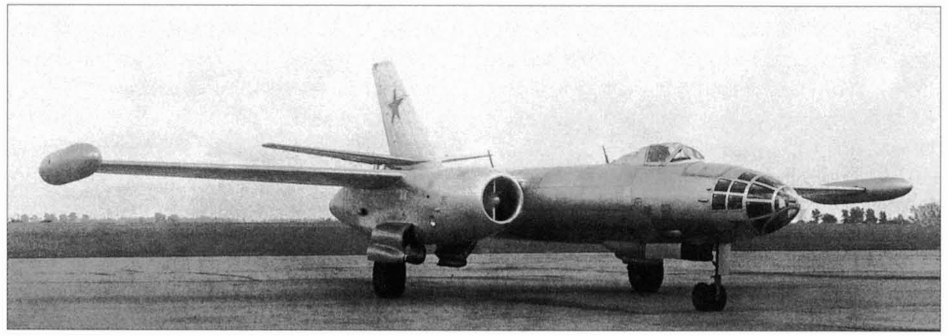
Top: As distinct from the combat versions, the IL-28U lacked armament and radar.
Above: A Naval Air Arm instructor shows an IL-28U's cockpit to a cadet; another cadet inspects the nose gear.



Ilyushin Aviation Complex

Above: The prototype of the IL-28R reconnaissance aircraft; note the twin dorsal aerials.

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Above: The IL-28R was exported to several of the Soviet Union's satellite nations, including East Germany. The reconnaissance version was identifiable by the wingtip tanks.

1,260 x 390 mm (49.6 x 15.35 in) instead of the usual 1,150 x 355 mm (45.27 x 13.97 in); besides, the landing gear was actuated hydraulically, not pneumatically, and retracted in just eight seconds – much faster than on the standard bomber. The higher gross weight of the IL-28R also led the designers to introduce a unique feature minimising wear and tear on the tyres: the mainwheels were spun up automatically by hydraulic motors when the gear was extended. According to the crews, this resulted in an exceptionally smooth touchdown.

Due to the installation of camera controls the starboard fixed NR-23 cannon had to be deleted as a weight-saving measure. The PSBN-M radar was sometimes removed as well; in that case 110 kg (240 lb) of ballast were carried in the navigator's compartment for CG reasons. Some changes were made to the avionics fit; the reconnaissance version featured a Magniy-M (Magnesium-M) IFF interrogator, an RSB-5 communications radio with a US-P receiver, an RSIU-3 command radio, an SPU-5 intercom, RV-2 and RV-10 radio altimeters, an SP-50 ILS etc. For over-water flights the IL-28R could carry an LAS-3 inflatable rescue dinghy (***lod**ka avareeyno-spa**sah**tel'naya*) in the bomb bay; this could be dropped either by the pilot or the gunner and inflated automatically by a rip cord.

The performance of the IL-28R was broadly similar to that of the basic bomber, except that range in high-altitude cruise increased to 3,150 km (1,956 miles); the combat radius was 740 km (460 miles) at 5,000 m (16,400 ft) and 1,140 km (708 miles) at 10,000 m (32,810 ft). Indicated airspeed was limited to 750 km/h (465 mph) at up to 4,000 m (13,120 ft) and Mach 0.78 above that altitude. Kokkinaki reported that handling and cockpit visibility were unchanged. High-speed aerial photography at various altitudes did not affect piloting techniques. The autopilot, as well as the heated and pressurised cockpits, reduced crew fatigue, which is especially important for a reconnaissance aircraft.

Initial flight testing was completed on 29th June 1950. After passing the State acceptance trials on 23rd November the IL-28R was ordered into production on 8th December 1951 and joined the VVS inventory. Initially the reconnaissance version was built in Moscow, but from 1953 onwards IL-28R production was passed on to aircraft factory No.39 in Irkutsk which had previously built the Tu-14T.

IL-28RTR ELINT aircraft

Apart from the IL-28R PHOTINT aircraft, the Beagle also had an electronic intelligence (ELINT) version designated IL-28RTR ([*samo**lyot***] ***rah**diotekhn**ich**eskoy razvedki*) reconnaissance aircraft powered by VK-1 engines. Outwardly it could be identified by a second teardrop-shaped dielectric fairing installed in lieu of the faired-over bomb bay doors. The IL-28RTR was supplied both to the VVS and the air forces of some of the Soviet Union's allies, including Czechoslovakia and Hungary.

IL-28REB (?) ECM aircraft

Another specialised version was intended for electronic countermeasures (ECM). Some sources claim the aircraft was designated IL-28REB ([*samo**lyot***] ***rah**dioelek**tron**noy bor'**byy*** – ECM aircraft). The main identification feature of this version was the cylindrical wingtip pods reminiscent of the IL-28R's drop tanks but featuring dielectric front portions concealing emitter antennas. The ECM version was also supplied to Czechoslovakia.

IL-28 radiation reconnaissance aircraft

The Soviet Air Force's 647th Special Composite Support Air Regiment operating in support of the 71st Nuclear Weapons Proving Ground in Semipalatinsk, Kazakhstan, operated two IL-28s fitted with air sampling pods for radiation reconnaissance. Compressed air bottles were installed in the bomb bays to pressurise the cockpits, ensuring that radioactive products would not enter. As an additional protective measure the cockpit walls were lined with lead, and radiometers were provided for the crew. Together with similarly modified aircraft and helicopters of various types these *Beagles* flew through radioactive clouds in the wake of nuclear tests, measuring radiation levels.

Edice Triada

A Czechoslovak Air Force example of the ECM version presumably designated IL-28REB. Note the dielectric portions of the wingtip emitter pods.

IL-28 torpedo-bomber conversion

The AVMF also operated the IL-28 from August 1951; this aircraft suited the Soviet Navy better than the Tu-14, being lighter and more agile. Initially the naval IL-28s were operated in standard bomber configuration; however, as early as 1st June 1950 the Council of Ministers ordered the development of a torpedo-bomber version. The bomb bay was modified to carry one RAT-52 rocket-propelled torpedo internally. Developed by NII-2 (later GosNII AS), this weapon was conceived as a homing torpedo, but the guidance system was considered too complicated and was deleted in the production version. The torpedo weighed 627 kg (1,380 lb) and had a 243-kg (535-lb) warhead.

Before dropping the torpedo the navigator set its travel depth (2-8 m/6.5-26 ft), charged the torpedo's condensers and began the run-in to the target as usual. At the proper moment the bomb sight automatically triggered the drop mechanism. One second later a small propeller-shaped drag parachute deployed and the torpedo descended vertically, dropping fast like a bomb. The main parachute deployed at 500 m (1,640 ft), reducing descent speed. It separated when the torpedo entered the water; next, nose-mounted rudders were brought into play to turn the torpedo horizontally and were jettisoned immediately afterwards. Then the solid-fuel rocket motor fired and the torpedo accelerated to 58-68 kts (66-80 mph); by comparison, conventional torpedoes with steam turbines could not travel faster than 40-45 kts (46-51 mph). Time from drop to impact was only 35 seconds, which left the target no time for evasive action.

The chief shortcoming of the RAT-52 was the rocket motor's short burn time resulting in a range of only 550-600 m (1,800-1,970 ft) which took the bomber uncomfortably close to the target (within range of the ship's air defences). On the other hand, the torpedo could be dropped at any altitude between 1,500 m (4,920 ft) and the aircraft's service ceiling at a speed of up to 800 km/h (496 mph), which was of particular importance for jet torpedo-bombers. Live drops at the Soviet Navy's test range showed a 'kill' probability of 17-38% in a single-torpedo attack.

During trials held on the Black Sea in September-November 1952, Tu-14T and modified IL-28 torpedo-bombers successfully dropped 54 RAT-2 torpedoes, both inert and live ones; targeting was done using an OPB-6SR sight on both aircraft. The RAT-52 was officially included in the AVMF inventory on 4th February 1953. It could be carried by Tu-14T torpedo-bombers and converted IL-28s (deliveries of the latter began that year). With one torpedo the modified IL-28T had a 18,400-kg (40,560-lb) TOW and a top speed of 906 km/h (562 mph); service ceiling and range were 12,500 m (41,010 ft) and 2,400 km (1,490 miles) respectively.

However, the converted IL-28 had some serious deficiencies. It carried only about one third of its design payload and could not carry other models of torpedoes internally, as they were too long to fit into the standard bomb bay. Also, the Soviet naval air arm had large stocks of pre-war 45-36MAN torpedoes (that is, 450-mm/17¾-in. calibre, 1936 model; MAN = [*tor**ped**a*] *modernizeerovannaya aviatsionnaya nizkovysotnaya* – updated aircraft torpedo for low-altitude attacks) which it wished to use on the IL-28. However, it turned out that the bomber's high speed rendered these torpedoes unsuitable. The weapon had to undergo a lengthy upgrade programme, emerging in 1956 as the 45-56NT torpedo which could be dropped at 120-230 m (390-750 ft) and 550-600 km/h (341-372 mph).

IL-28T torpedo-bomber (first use of designation)

Apparently the engineers had been aware of the shortcomings of the 'quick fix' torpedo-bomber conversion all along, because development of a dedicated torpedo-bomber designated IL-28T (*torpedo**nos**ets*) also began in 1950. The mock-up review commission signed the act of acceptance on 7th July that year.

The aircraft was intended for high- and low-altitude torpedo attacks and minelaying. It differed from standard IL-28s and those converted into torpedo-bombers primarily in having a weapons bay lengthened from 4.18 m (13 ft 8¼ in) to 6.66 m (21 ft 10¼ in) and having the wings moved back 100 mm (3 15/16 in), with appropriate changes to the fuselage structure. The modification of the weapons bay and the provision of an LAS-3 rescue dinghy required changes to the Nos 2, 3, 4 and 5 fuel cells. This reduced internal fuel capacity from 8,000 litres (1,760 Imp gal) to 4,770 litres (1,269.4 Imp gal) and the fuel load from 6,600 kg (14,550 lb) to 5,080 kg (11,200 lb). To compensate for this the IL-28T had provisions for 950-litre (209 Imp gal) tip tanks each holding 750 kg (1,650 lb) of fuel, as on the IL-28R.

The starboard fixed NR-23 cannon was deleted, as was the AFA-33/75 (or NAFA-MK) camera. Instead, two AFA-BA/400 vertical cameras and an AKS-1 hand-driven ciné camera were installed to record the strike results. Other new equipment items included a Magniy IFF interrogator, a PTN-45 low-altitude sight (***pritsel** torpednyy **nizko**-vy**sot**nyy* – sight optimised for low-level torpedo drops) and a separate PP-1 high-altitude sight also used for dropping anti-shipping mines; a model 1010 electric heater was provided to defrost the sighting window of the PTN-45. Some

Wojskowa Agencja Fotograficzna

Above: This view of a Polish Air Force IL-28R serialled '03 Red' (c/n 2905) illustrates the lack of the starboard forward-firing cannon on the reconnaissance version.

Wojskowa Agencja Fotograficzna

Another aspect of the same aircraft, showing the black anti-glare panels on the inboard faces of the tip tanks.

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Above: The second prototype of the new-build IL-28T torpedo-bomber (c/n 50301104) at Moscow-Khodynka. Note the altered nose glazing and the undernose Perspex blister enclosing the PTN-45 sight.

Yefim Gordon archive

The designation IL-28T also applied to aircraft converted from regular bombers. Here an RAT-52 rocket-propelled torpedo (note foreplanes) is about to be loaded into such an aircraft.

equipment items were relocated and additional armour protection provided for the pilot and navigator.

The normal ordnance load was 1,000 kg (2,204 lb), which permitted carriage of one torpedo of various models (45-36AVA, TAS, TAV, RAT-52 or A-2), or two AMD-500 anti-shipping mines, or one AMD-1000, AMD-M or Type A mine. If necessary the IL-28T could carry up to 3,000 kg (6,610 lb) of weapons at the expense of a reduced fuel load and hence shorter range. In that case possible weapons configurations were two 45-46AMV torpedoes totalling 1,940 kg (4,280 lb), or one 1,500-kg (3,310-lb) TOZ torpedo, or one 1,100-kg (2,425-lb) AMD-1000 mine, or four AMD-500 mines (2,000 kg/4,410 lb), or two Serpey mines (2,500 kg/5,511 lb), or two Lira (Lyre) mines (1,940 kg/4,280 lb), or two Desna mines (1,500 kg). (The meaning of the name *Ser**pey*** is not known but it sounds suspiciously like an anagram of *Per**sey*** (Perseus).)

Despite the relocated wings, the external dimensions were identical to those of the IL-28R. The IL-28T could be refitted and used as a conventional bomber with a bomb load equal to that of the standard *Beagle*.

Prototype conversion was completed in 1950. The first prototype IL-28T (c/n 50301106) first flew on 8th January 1951 with Vladimir K. Kokkinaki at the controls; N. D. Sorokin was the flight engineer and A. P. Vinogradov was the engineer in charge of the flight tests. The second prototype (c/n 50301104) joined the programme on 12th March 1951, making its maiden flight from Khodynka – again at the hands of Vladimir K. Kokkinaki. Outwardly the IL-28T prototypes differed from standard *Beagles* in having a small Perspex blister under the nose accommodating the lower part of the PTN-45 sight, an altered navigator's glazing framework and a non-standard angular cockpit windshield with a rectangular windscreen and optically flat sidelights.

The manufacturer's tests were completed on 17th April 1951 (the test report was endorsed six days later). Then the IL-28T was submitted to the Soviet Navy's Research Institute No.15 for State acceptance trials which proceeded from 7th June to 25th July 1951 and also went successfully. In August 1951 the complete set of manufacturing documents was transferred to one of the production factories; the type entered limited production and service with the AVMF (some sources, though, claim the IL-28T did not enter production due to the protracted development of the 45-56NT torpedo and the inability to carry two RAT-52 torpedoes internally). For this achievement a group of OKB-240 employees was again nominated for the Stalin Prize.

IL-28T torpedo-bomber conversion (second use of designation)

In 1954 the improved 45-54VT torpedo (that is, 450-mm calibre, 1954 model, VT = *vy**sot**noye tor**ped**ome**tah**niye* – high-altitude torpedo attack) was included in the AVMF arsenal, followed by the 45-56NT torpedo (NT = ***niz**koye tor**ped**ome**tah**niye* – low-altitude torpedo attack) two years later. Both types were powered by steam engines and were carried by the Tu-14T along with the RAT-52. In order to standardise the armament carried by Soviet torpedo-bombers and increase their punch it was decided to upgrade the IL-28s then in service.

To this end a standard IL-28 torpedo bomber was retrofitted with two external BD-4T torpedo racks (***bah**lochnyy der**zhah**tel'* – beam-type [weapons] rack). The increased payload meant that the centre fuselage frames had to be reinforced. The aircraft was also fitted with the new PTN-55 low-altitude sight, albeit incomplete, which was concurrently being tested on a modified Tu-14T. This allowed the navigator to programme the torpedo to move in a zigzag (this feature was supposed to increase kill probability but demanded a substantial increase in the torpedo's range) and feed target data into the torpedo's control module up to the moment of release.

The modified aircraft – which, rather confusingly, was again designated IL-28T – could carry three RAT-52 torpedoes (two externally and one internally) or two 45-54VT or 45-36NT torpedoes externally; alternatively, two AMD-500 anti-shipping mines could be carried externally. The weapons were dropped at altitudes of 40-400 m (130-1,310 ft) and speeds of 360-800 km/h (223-496 mph).

However, the Navy was displeased, claiming the required modifications were too extensive. Besides, the high-drag external stores impaired the aircraft's performance and caused some restrictions on piloting techniques. Rotation at take-off became very difficult; the aircraft experienced severe vibration at high speed caused by the turbulence generated by the external torpedo racks. Tailplane buffet was commonly encountered in a shallow dive when two torpedoes were carried externally; if one torpedo was carried the asymmetrical drag generated by it rendered turns in the opposite direction impossible.

The aircraft completed its trials programme in 1955. All its shortcomings notwithstanding, the Navy expected to modify some of its IL-28s to this standard. However, this conversion programme never materialised because the IL-28 was getting long in the tooth and the Soviet bomber and torpedo-bomber force was re-equipping with the more modern Tu-16. Still, the PTN-55 sight did find its way into service.

IL-28N (IL-28A) nuclear-capable bomber

The Soviet military doctrine of the early 1950s demanded that tactical aviation was to possess nuclear capability. Several types of small tactical nuclear weapons, including the RDS-4 Tat'yana bomb, were under development at the time, and the Soviet government issued a directive demanding the development of new tactical bombers capable of delivering them. However, this would clearly be a time-consuming process, so it was decided to modify existing aircraft in service with the VVS, including the IL-28, for the 'nuke 'em' role.

First, two IL-28s were specially modified by OKB-30 (the design bureau of MMZ No.30) for testing the RDS-4 according to the specifications passed by OKB-11 which had developed the bomb. Among other things, the modification involved heat insulation and heating of the bomb bay, installation of special equipment to monitor the weapon's systems status, as well as test equipment to measure the parameters of the explosion, including ciné cameras capturing the development of the famous mushroom cloud.

The first drop of an RDS-4 from the IL-28 took place on 23rd August 1953. On that occasion the bomb was in the so-called check configuration with data link sensors and a conventional warhead. The aircraft was flown by pilot V. I. Shapovalov, navigator/bomb-aimer A. V. Koz'minykh and gunner/radio operator B. S. Soodakov. The weapon was dropped at 11,000 m (36,090 ft), detonating successfully at the preset altitude. Four RDS-4 bombs were dropped, with a day's interval in each case, between 29th September and 5th October 1954. All in all the test programme involved more than 50 flights, 15 of which were weapon drops; the safety of landing with an unused bomb was checked, among other things.

After the successful completion of the trials the RDS-4 entered production; so did the nuclear-capable version of the Beagle which was designated IL-28N (*no**si**tel'* [***spets**boyepri**pa**sa*] – carrier of 'special', that is, nuclear munitions). Apart from the changes to the bomb bay, the aircraft differed from the standard bomber in having an updated avionics suite. The PSBN-M ground mapping radar was replaced by an RBP-3 unit (***rah**diolokatsi**on**nyy bombardi**rov**ochnyy pri**tsel*** – radar bomb sight) in a much deeper radome.(Some sources claim the IL-28N was outwardly identical to the standard bomber). It indicated headings, distance to ground waypoints, altitude above such waypoints, ground speed and aircraft position. The bomb bay was provided with a heating system to keep the nuclear bomb's systems from freezing up, and the cockpits featured shutters protecting the crew from the flash of the nuclear explosion. An RSIU-5V UHF communications radio, a US-8 receiver, RV-18 and RV-2 radio altimeters were fitted. The electrical system was modified to include PO-3000 (main) and PO-3000A (reserve) single-phase AC transformers.

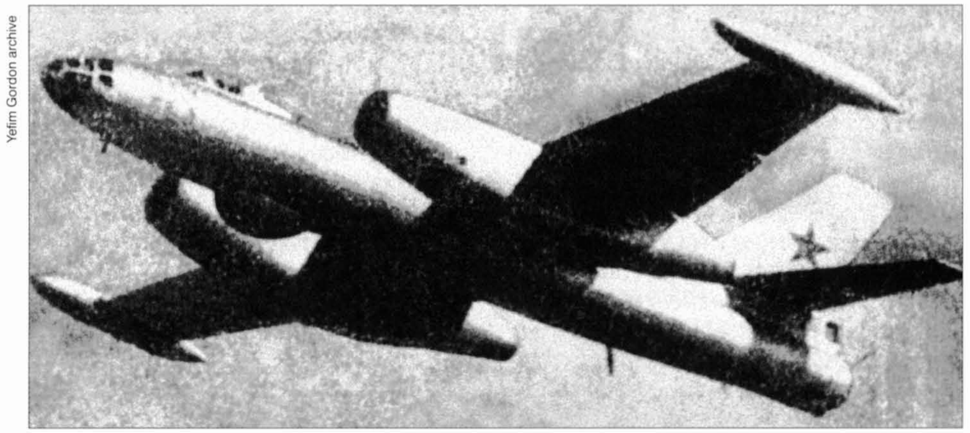
The IL-28N's empty weight was 13,040 kg (28,747 lb) – 150 kg (330 lb) more than the standard bomber's; TOW was 18,550 kg (40,895 lb). The CG had shifted slightly aft but this had virtually no effect on the aircraft's handling and performance.

42 IL-28Ns were deployed to Cuba in 1962 during the Cuban missile crisis. This version is sometimes referred to as IL-28A (***ah**tomnyy* – 'atomic', that is, nuclear-capable).

IL-28S tactical bomber project

In 1949-50 OKB-240 sought ways of further improving the design of the basic IL-28. The main objective was to increase the bomber's speed and range. This was to be achieved by mating the existing fuselage and tail surfaces with all-new wings swept back 35° at quarter-chord and installing more powerful and fuel-efficient Klimov VK-5 centrifugal-flow turbojets. The VK-5 was a derivative of the production VK-1A uprated to 3,100 kgp (6,830 lbst) for take-off and 2,760 kgp (6,080 lbst) for cruise, differing mainly in having a more efficient compressor; the engine's dry weight and external dimensions remained unchanged. This undoubted achievement was made possible by the use of new heat-resistant alloys, a higher turbine temperature and more efficient cooling. The specific fuel consumption (SFC) was 6% lower as compared to the production VK-1A.

However, preliminary design studies showed that the swept-wing IL-28S (*strelo**vid**noye krylo* – swept wings) offered no significant advantages over the production model. Moreover, the incorporation of new wings would incur major technological problems. Hence development of the IL-28S was abandoned – a decision later proven correct by the chief competitor's negative experience. The Tupolev OKB had achieved scant success with the experimental '82' (Tu-82) swept-wing tactical bomber (which, incidentally, closely resembled the would-be IL-28S).



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Above: This aircraft with a non-standard deep radome is probably a nuclear-capable IL-28N (IL-28A).

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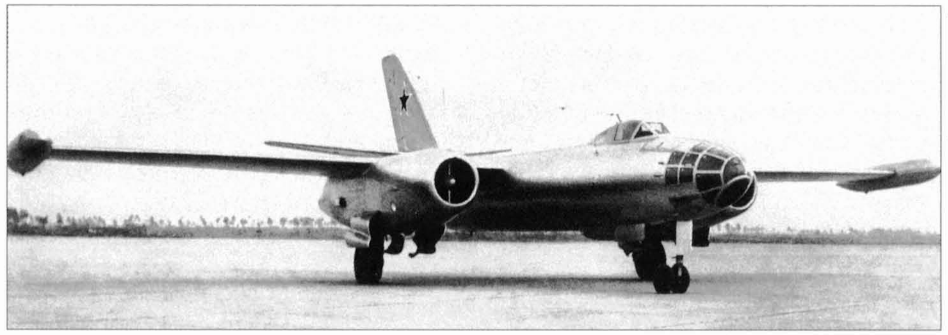
This IL-28 features non-standard bulged bomb bay doors to accommodate two RAT-52 torpedoes.



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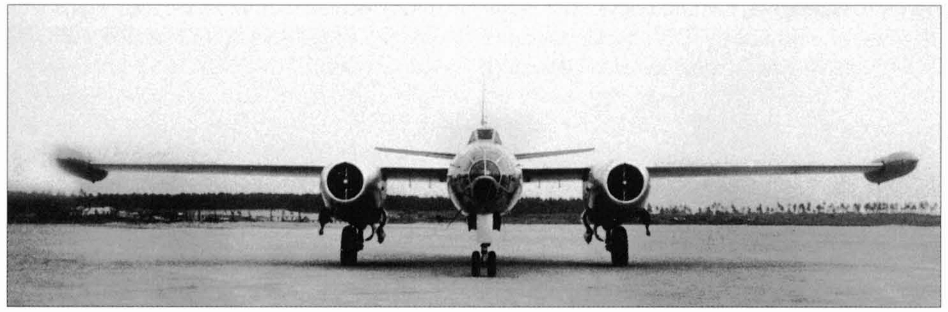
Above: Three-quarters front view of the IL-28RM prototype (c/n 52003714); note the angular windshield.



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A full frontal of the IL-28RM.

IL-28RM tactical reconnaissance aircraft prototype

Meanwhile, the Ilyushin OKB attempted to introduce the new VK-5 powerplant on production versions of the straight-wing IL-28. Several government directives and MAP orders were issued, envisaging the installation of VK-5s on all three principal versions of the *Beagle* – conventional bomber, torpedo-bomber and reconnaissance aircraft.

The latter version received the highest priority, since the VVS was pretty desperate to extend the reach of its tactical reconnaissance aircraft. The PHOTINT aircraft then under development at the Mikoyan (OKB-155) and Yakovlev (OKB-115) design bureaux were *a priori* handicapped by inadequate range, being derived from tactical fighters; conversely, the IL-28R and the '78' (Tu-78, the PHOTINT version of the Tu-14) were based on bombers designed to have much longer range. The 3,000-km (1,863-mile) range target was to be met by installing more fuel-efficient engines.

On 3rd August 1951 the Council of Ministers issued directive No.2817-1388ss ordering the development of the IL-28RM ([*samo**lyot***-] *raz**ved**chik, modifi**tseer**ovannyy* – reconnaissance aircraft, modified) powered by VK-5 engines. The deadline for submission for State acceptance trials was set at March 1952 – a tight schedule which proved impossible to maintain. The unserialled IL-28RM prototype (c/n 52003714) first flew on 17th February 1952 but the manufacturer's flight tests were not completed until 12th April (the test report was signed on 29th April); thus the State acceptance trials did not commence until 10th July. The trials were duly completed on 15th January 1953.

The IL-28RM featured the latest version of the intended powerplant – the VK-5E (*eko-no**mich**nyy* – fuel-efficient) incorporating additional measures aimed at reducing the SFC. This engine passed its State acceptance trials concurrently with the aircraft itself. The new engines necessitated a redesign of the engine bearers and engine nacelle structure, the engine control system had to be modified and the lower skins of the outer wings stiffened. No changes were made to the armament and equipment.

Still, the good performance of the aircraft and its powerplant did not help. Due to the scrapping of the IL-28S and Tu-93 projects for which the new engine was primarily intended (the Tu-93 was a VK-5 powered version of the Tu-14) the VK-5 did not enter production – and thus neither did the IL-28RM. Besides, it was clear by then that axial-flow turbojets were superior to centrifugal-flow engines.

IL-28 experimental tactical bomber with VK-5 engines

The next version to be powered by VK-5s was the regular bomber. Logically this aircraft should have been designated IL-28M, but no separate designation was allocated for some reason and the designation IL-28M was eventually used for another version (see below). Development of the re-engined bomber variant was initiated by Council of Ministers directive No.5329-2088ss of 29th December 1952 and MAP order No.1ss of 1st January 1953.

The two prototypes were converted from standard Moscow-built IL-28s (c/ns 52003701 and 52003719). Pursuant to the above-mentioned CofM directive the first prototype was to be transferred to LII for testing, while the other aircraft was to be delivered to NII VVS in April 1953 for State acceptance trials.

Apart from the engines, the bombers had a few other changes. Both aircraft had wings taken from the IL-28R, with wingtip drop tanks to extend range. The second prototype featured enlarged 1,260 x 390 mm (49.6 x 15.35 in) mainwheels borrowed from the IL-28R and an automatic wheel brake system, while the first prototype retained standard 1,150 x 355 mm (45.27 x 13.97 in) mainwheels. The 12-A-30 DC batteries were replaced by new 12SAM-25 batteries and moved forward to the radar bay to shift the CG forward.

The defensive armament was identical to that of the standard IL-28, comprising two nose-mounted NR-23s with 100 rpg and two NR-23s with 225 rpg in the tail turret. The normal and maximum bomb loads were 1,000 kg (2,205 lb) and 2,000 kg (4,410 lb) respectively.

Both aircraft were completed within a short time frame and duly tested; the manufacturer's flight tests report was endorsed on 28th April 1953 and the State acceptance trials report exactly three months later.

On 10th September 1953 NII VVS concluded that it would be advisable to launch series production of the VK-5 powered IL-28. Still, the upgraded bomber did not enter production for the reasons stated above.

IL-28TM torpedo-bomber prototype

The IL-28TM torpedo-bomber (*torpe-do**no**sets modifi**tsee**rovannyy*) was the last of the three Beagle variants modified to take the VK-5 engine. It was developed in accordance with Council of Ministers directive No.7218rs of 22nd May 1953 and Ministry of Defence Industry (MOP – *Mini**ster**stvo obo**ron**noy pro**myshl**ennosti*) order No.295ss of 27th May. The schedule stipulated by the Government was extremely tight: the prototype was to be handed over to the Navy's Research Institute No.15 in just one month.

In those days it was customary in the Soviet Union to strictly comply with government orders and directives concerning the defence industry, whatever the cost. OKB-240 managed to complete the prototype on schedule by converting one of the IL-28T prototypes (c/n 50301106). (The c/n shows that the aircraft was built in 1950, so this was probably a development aircraft retained by the Ilyushin OKB). The installation of VK-5 engines with new extension jetpipes led to several associated changes. The front parts (detachable engine cowlings) and rear parts of the nacelles were modified, the electric wiring inside the nacelles was rerouted and the engine cooling ducts modified. Changes were also made to the engine controls, a new fire extinguishing system was installed and the engines' foreign object damage (FOD) protection screens made of wire mesh were provided with a de-icing system.

Furthermore, a seventh fuel cell (No.3B) was added, drop tanks were installed at the wingtips and the liquid oxygen bottles were relocated. The higher gross weight required the standard mainwheels to be replaced with 1,260 x 390 mm (49.6 x 15.35 in) mainwheels as on the IL-28R. Finally, a second nose cannon with 100 rounds was installed on the starboard side (as already mentioned, the production IL-28T had only the port side forward-firing cannon).

Serialled '4 Red', the aircraft completed its manufacturer's flight tests by late June 1953 (the test report was signed on 30th June) and passed State acceptance trials in July (the Soviet Navy's Research Institute No.15 issued its Act of acceptance on 1st August). Still, the IL-28TM fared no better that its 'comrades-in-engines' (the other versions sharing the VK-5 powerplant).

IL-28-131 guided bomb carrier

Back in the early 1950s the Soviet Union started experimenting with precision guided munitions (PGMs). An experimental batch of UB-2000F radio-controlled guided bombs (UB = *oopravlyayemaya bomba* – guided bomb) was built as early as 1953 and tested on specially modified IL-28 and Tu-4 bombers. Designed by a team under A. D. Nadiradze, the UB-2000F bore a certain resemblance to the German Fritz X gliding bomb of Second World War vintage, with a squashed-X wing arrangement to provide adequate ground clearance. However, the wings were of delta planform with inset rudders and the casing had a constant diameter (in contrast, the German bomb had trapezoidal wings and a bulged warhead).

Tests showed that two or three 'smart bombs' were enough to destroy a target measuring 30 x 70 m (100 x 230 ft) which would have required the expenditure of 168 FAB-1500 'dumb bombs'. Hence in 1955 the UB-2000 entered production and was included into the VVS inventory as the UB-2F Chaika (Seagull) or 4A-22. About 30 IL-28s specially equipped to carry these PGMs were built in 1956. This weapon was carried externally under the fuselage. Outwardly the IL-28-131 could be identified by a small angular fairing under the nose, probably housing the guidance antenna for the bomb.

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Above: The IL-28TM ('4 Red') was converted from the first prototype IL-28T (c/n 50301106); note the non-standard nose glazing.

The UB-2F was also carried by specially modified Tu-16 *Badger-A* bombers which carried two such bombs on underwing pylons.

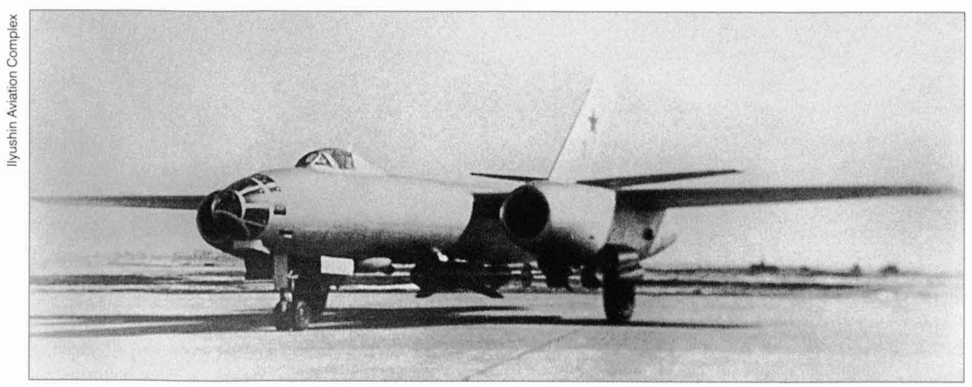
IL-28PL anti-submarine warfare aircraft

The late 1950s and early 1960s saw another escalation of the Cold War which nearly turned into a full-blown 'hot' war during the Cuban missile crisis. The deployment of Soviet ballistic missiles to Cuba worried the USA and their NATO allies immensely, causing them to step up their submarine activities. This, in turn, led the Soviet Union to bolster its Navy, including the naval air arm. Not having enough ASW aircraft to monitor the activities of Western navies along the Soviet Union's marine borders and destroy the enemy in case of need, the AVMF decided to convert some of the bombers it had on strength.

The aircraft converted for the ASW role were mostly Tu-16s and IL-28s. For instance, the Baltic Fleet's 759th OMTAP (*ot**del'**nyy **min**no-tor**ped**nyy avia**polk*** – independent minelaying and torpedo-bomber regiment) (some sources state the unit as the 769th OMTAP) converted ten IL-28 bombers and IL-28T torpedo-bombers which were redesignated IL-28PL (*protivo**lod**ochnyy* – anti-submarine). These aircraft were fitted with the SPARU-55 sonobuoy receiver (*samo**ly**-**ot**noye pree**yom**noye avtoma**tich**eskoye rah**dioustroy**stvo* – 'airborne automatic radio receiver device', 1955 model) constituting part of the Baku sonar system recently adopted by the AVMF (the same system was fitted to the Kamov Ka-25PL shipboard ASW helicopter). The bomb bay was big enough to carry RGB-N sonobuoys (***rah**dio-**ghid**roakoos**tich**eskiy booy*) and depth charges without requiring modifications.

The SPARU-55 was a superheterodyne receiver working in the 49.2-53.4 MHz waveband. This range was split into 18 preset frequencies through which the receiver cycled automatically. If a signal from a sonobuoy was detected on one of the frequencies, the receiver locked onto it, enabling the operator to determine if the sonobuoy had really detected a submarine. If that was the case, he activated the SPARU-55's direction finder mode and the aircraft homed in on the operating buoy to attack the submarine. A major drawback of the SPARU-55 was its long cycling time (in automatic mode it needed 110 seconds to switch from one buoy to the next!). An outward identification feature of the IL-28PL may have been several additional blade aerials on the aft fuselage underside; these were probably associated with the SPARU-55 receiver.

In 1962 the AT-1 ASW torpedo was included into the AVMF inventory; it could also be carried internally by the IL-28PL,



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An IL-28-131 with a UB-2F Chaika guided bomb carried externally under the fuselage. Note the characteristic angular bulge under the nose associated with the bomb guidance system.

being 3.9 m (12 ft 9½ in) long and weighing 530 kg (1,170 lb).

Officially the reason for the IL-28PL's existence was the necessity to provide ASW support quickly once it had been requested by whoever spotted the 'unfriendly' sub, since the IL-28 was more than twice as fast as the obsolete piston-engined Beriyev Be-6 flying boat operated by the Soviet Navy at the time. Besides, the flying boats were difficult to operate in winter when their bases froze up. But perhaps the real reason was the Soviet Navy command's wish to stop the 'Beagle kennels' from being disbanded, as they inevitably would be, and keep the pilots flying. In 1966 the HQ of the Baltic Fleet Air Arm approached the Soviet Navy GHQ, requesting the formation of two regiments equipped with the IL-28PL, but the request was turned down.

IL-28Sh attack aircraft

In the late 1950s the Ilyushin OKB considered adapting the IL-28 for the strike role. This involved installation of a battery of 20 unguided rockets in the bomb bay. This would give adequate firepower without spoiling the aircraft's aerodynamics with high-drag external stores. The launch tubes were to be mounted almost vertically, firing down and aft; a salvo of rockets equipped with shaped-charge warheads was expected to be an effective way of destroying armoured vehicles. The crew was reduced to two, the navigator/bomb aimer being eliminated. However, it was quickly established that the efflux of 20 rockets impinging on the airframe would make the aircraft lose control, and the idea was dropped.

However, the limited warload of the fighter-bombers of the period forced the military and the engineers to dust off the idea of an IL-28 attack aircraft. The specification for such an aircraft was drawn up in the spring of 1967 – before the famous Six-Day War, in fact. The aircraft was to have a combat radius identical to that of the Sukhoi Su-7BM fighter-bomber but an ordnance load two or three times greater.

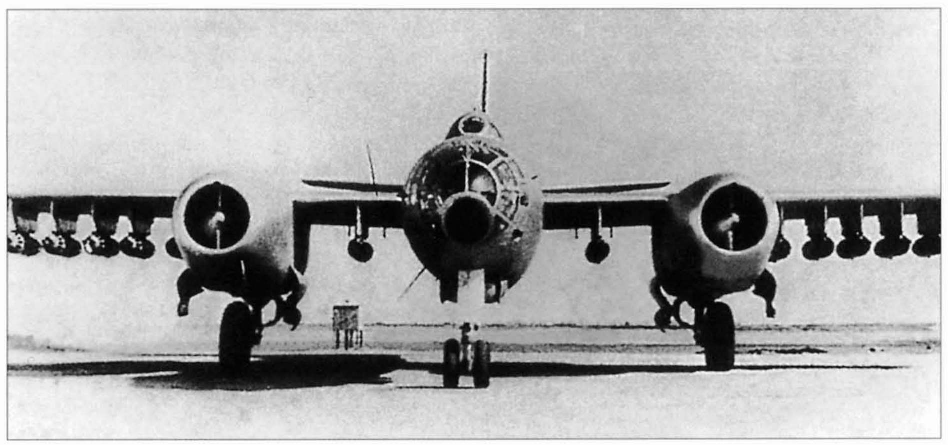
The result was the IL-28Sh (*shtoor**movik*** – attack aircraft). It featured 12 underwing pylons for unguided rockets – five outboard and one inboard of each engine. This was considered a more acceptable approach, even at the expense of the extra drag created by the external stores.

Possible weapons configurations included twelve UB-16-57 rocket pods with sixteen 57-mm (2.24-in) S-5 folding-fin aircraft rockets (FFARs) each, or six 250-mm (9.84-in) S-24 rockets, or various gun pods, submunitions containers and free-fall bombs. (UB = *oonifi**tsee**rovannyy blok* – standardised [FFAR] pod; S = *sna**ryad*** – in this case, unguided rocket.) Depending on the mission, the pilot could select a salvo launch or just two pylons, four pylons and so on. Flight tests, which began in 1967, showed that even when all 192 S-5 rockets or all six S-24 rockets were fired at once, the engines showed no inclination to surge or flame out.

The IL-28Sh commenced State acceptance trials in October 1967. The test pilots reported that the aircraft was suitable for low-level and ultra-low-level strike missions. It was established that flying at – and accurate rocket/bomb strikes from – altitudes right down to 60 m (200 ft) could be mastered by service pilots without any trouble; flying still lower, though, demanded a lot of concentration and extra training. The aircraft could be prepared for a sortie within four hours.

Below 200 m (656 ft) the IL-28Sh had a speed limit of 660 km/h (410 mph). Fuel consumption at low altitude increased by 30-50% as compared to the basic bomber because of the external stores and the aircraft's combat radius with a full load of FFAR pods was 295 km (183 miles).

Yet, despite all its merits as a strike aircraft, the IL-28Sh had inadequate armour protection and the ejection seats were not yet of the zero-zero type, which meant the crew had no chances of survival if shot down at low altitude. Hence the Ilyushin OKB discontinued development of the IL-28Sh and, though originally 300 IL-28 bombers were slated for conversion for the ground-attack role, only a few were eventually converted at the Soviet Air Force's aircraft overhaul plants and delivered to first-line units.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Front view of the IL-28Sh attack aircraft with UB-16-57 rocket pods on all 12 pylons.

IL-28ZA weather reconnaissance aircraft

On 23rd February 1959 the State Committee for Aviation Hardware (GKAT – *Gosoo**dar**stvennyy komi**tet** po aviatsi**on**noy **tekh**nike*) issued an order concerning the development of the IL-28ZA weather reconnaissance aircraft (*zondi**rov**shchik atmos**fe**ry* – lit. 'atmosphere sampler') for civil aviation needs. A few *Beagles* were converted to this configuration. Unfortunately almost nothing is known about this version. (In 1957 MAP lost its ministerial status along with several other ministries and was 'demoted' to a State Committee due to Soviet leader Nikita S. Khrushchov's disdainful attitude. After Khrushchov was unseated in 1965, GKAT regained its original name and 'rank'.)

Target-towing versions

Soviet versions (IL-28BM)

Two versions (the basic bomber and the IL-28R) were widely used as target tugs – both for testing new AA guns and for training fighter pilots. The special equipment for this mission included a BLM-1000 (BLM-1000M) or BLT-5 winch installed in the bomb bay and a 77BM-2 (77BM-2M) or PM-3Zh winged target towed on a cable anywhere between 5 and 2,500 m (20-8,200 ft) long (BM = *book**si**rooyemaya mi**shen'*** – towed target; PM = ***plah**ner-mi**shen'*** – gliding target. Some sources stated a towing cable length of 20-2,500 m (65-8,200 ft).

For take-off and landing the target was connected to the aircraft by a rigid link permitting operation from both paved and unpaved strips. The bomber version used short linkage rods whereas the IL-28R was fitted with long ones. The installation of target-towing equipment did not seriously affect the aircraft's CG position which stayed well within the prescribed limits. The target-towing versions are sometimes referred to as IL-28BM (*booksi**rov**shchik mi**she**ney* – target tug).

The field performance of IL-28 bombers with a 20,100-kg (44,310-lb) gross weight and IL-28Rs with a 19,822-kg (43,699-lb) gross weight enabled them to operate with targets from concrete airstrips at least 1,800 m (5,905 ft) long. At a gross weight of 22,207 kg (48,957 lb) the IL-28R could operate with targets from concrete airstrips at least 2,300 m (7,540 ft) long. Endurance with a towed target was 2.5 hours.

When towed targets were supplemented by rocket-powered target drones the IL-28 target tugs were converted into combined tugs/drone launchers. The drones were carried on underwing pylons between the nacelles and fuselage in much the same way as the upgraded IL-28T carried torpedoes. They were launched and flew on towards the shooting range when the aircraft reached an appropriate altitude.

Apart from towed targets, the IL-28BM based on the standard bomber version could carry PM-6R and PM-6G droppable targets (PM = *pi**kee**ruyuschchaya mi**shen'*** – diving target). These looked rather like bombs with overgrown fins and were equipped with smoke tracers and recovery parachutes. The IL-28R and IL-28T could not be modified to carry these drones because of the reconnaissance and torpedo-bomber versions' increased TOW (which would be excessive if the drones were carried) and some structural details which rendered the conversion impossible.

The PM-6 drones were carried on special underwing pylons attached on two pairs of forward-swept V-struts. The delivery system spun up the drones' stabilising gyros, using power from the carrier aircraft, and dropped the drones singly or simultaneously at a preset altitude between 2,300 and 8,000 m (7,540- 26,250 ft). The drones were aimed using the optical sight or radar; in an emergency they could be dropped by either the pilot or the navigator. With two drones the aircraft's service ceiling was limited to 9,600 m (31,500 ft) and the take-off run increased by 300 m (980 ft).

East German version

The East German IL-28s converted into target tugs differed slightly from their Soviet counterparts, as no 'rigid' targets were used. A drum with a 2,000-m (6,560-ft) steel cable was carried in the bomb bay on the standard bomb cradles. To this a fabric 'sock' 8 m (26 ft) long and 1 m (3 ft) in diameter was attached; it was neatly rolled up and suspended from the bomb cradles before flight. A small roller was attached to the lower fuselage to stop the cable from scuffing the fuselage skin as it paid out. Some types of anti-aircraft guns (including the S-60) were radar-directed, so aluminium cones had to be inserted into the 'sock' to provide a radar signature.

Prior to entering the shooting range the pilot lowered the flaps 20° and slowed the aircraft to 280 km/h (174 mph) to prevent the target from being ripped apart or torn off by

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Top: '42 Blue', an IL-28BM based on the IL-28R (note the tip tanks), takes off with a 77BM-2 target attached by a rigid towbar. The position of the tactical code on the tail is noteworthy.

Above: An IL-28BM based on the bomber version flies with a 77BM-2 target in tow.

Right: A PM-6 droppable target under the wing of an IL-28BM; note the pylon design.

the slipstream as it unfolded. The navigator then dropped the target which unwound the cable as it deployed; the drum was fitted with a centrifugal brake to make sure the cable unwound smoothly. Two or three minutes later the target was fully deployed, the observer in the gunner's cabin monitoring it. All armament was usually removed.

When the sortie was completed the cable and target were jettisoned, usually by means of a pneumatic release mechanism, but the cable could also be cut by a pyrotechnic guillotine in case of malfunction. After landing the cable was rewound and ready for another mission; the target could also be reused, unless it was totally shot to shreds.

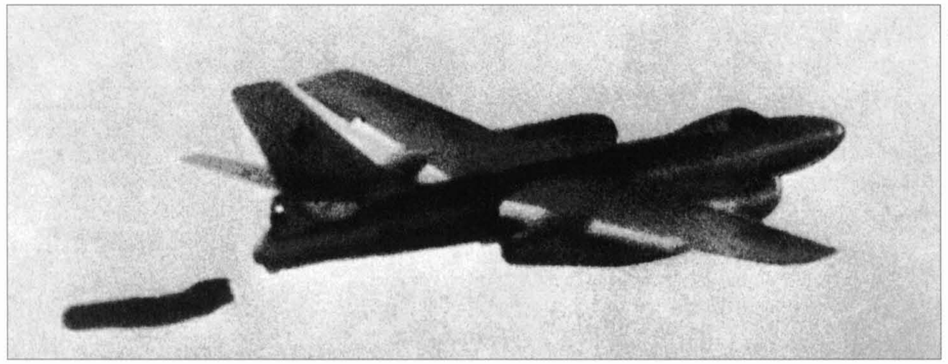
Romanian version

At least one Romanian Air Force Harbin H-5 (Chinese-built IL-28, see below) serialled '307 Red' was converted for target-towing duties, using equipment developed by the Air Target Sweden AB company. An MBV7S Mk 3 target towing winch was installed in the bomb bay, with a faired cable outlet amidships; the cable was 4,500 m (14,765 ft) long. The winch worked with a KR-45-430 sleeve-type target equipped with an AS-131SC acoustic miss distance sensor; the target was hooked up under the fuselage before flight.

IL-28M (M-28) target drone

In addition to towing targets, many *Beagles* ended up as targets themselves! In the late 1950s many obsolete IL-28 bombers were converted into remote-controlled high-speed target drones designated IL-28M (for ***mi**shen'* – target) or M-28 and used for testing new anti-aircraft missile systems. To be precise, development of this version was brought about by Semyon A. Lavochkin's OKB-301 which started design work on the Model 400 surface-to-air missile in 1955. This missile was intended for point defence of important targets, such as major industrial cities, and designed to destroy aircraft with a radar cross-section (RCS) similar to that of the IL-28.

The radio control system enabled the IL-28M to take off, climb to cruise altitude, make manoeuvres and land if the drone was lucky enough to stay in one piece. At first this was often the case – the first prototypes of the '400' SAM did not score a single hit on



Flieger Jahrbuch

A poor but interesting shot of an East German Air Force IL-28 towing a sleeve-type target.

the drones! Another anti-aircraft missile developed by the Lavochkin OKB, the Model 207A, was tested between June 1953 and November 1954; for instance, three test launches against IL-28Ms were made in October 1953, two of the missiles having shaped-charge warheads and the third a directional fragmentation warhead. State acceptance trials of the '207A' began in September 1953, using IL-28Ms and Tu-4s as targets. The target drones flew at 9,500-20,000 m (31,170-65,620 ft) and up to 35 km (21.7 miles) from the launch site. All the targets were either destroyed or substantially damaged, the missiles' accuracy being within 7-58 m (23-190 ft).

Not all IL-28Ms were radio-controlled, however. Some *Beagles* phased out by the VVS were given a 'brush-up' by the manufacturer to make sure some mechanical failure would not prevent the aircraft from fulfilling its final mission. Then a pilot would take the doomed bomber into the air, climb to a predetermined altitude, engage the autopilot and eject when told to do so by ground control. Test pilot Fyodor D. Bogdanov made 31 such flights in 1952-57, ejecting at 12,500 m (41,010 ft).

Test and development aircraft

Avionics testbeds

IL-28LL radar testbed: One IL-28 (identity unknown) was converted in 1952 for testing the RP-6 Sokol (Falcon) radar (RP = ***rah**dio-pri**tsel*** – 'radio sight'; this was the Soviet term for fire control radars at the time) and designated IL-28LL (*le**ta**yushchaya labora**to**riya* – lit. 'flying laboratory'; this Russian term is used indiscriminately and can denote any kind of testbed, an aerodynamics research aircraft or control configured vehicle, a weather research aircraft, a geophysical survey aircraft and so on). This radar with a 30-km (18.6-mile) detection range had been developed by OKB-339 under G. M. Koonyavskiy for two interceptors – the Yakovlev Yak-120, which entered production and service as the Yak-25, and the Lavochkin La-200B. Initial tests were performed on a converted Boeing B-17G Flying Fortress. (While this type was not officially supplied under the Lend-Lease programme, a number of B-17s which had crash-landed on Soviet-held bases after raids on Germany were repaired and used by the Soviet Air Force.) When it transpired that development of the Yakovlev fighter was taking longer than predicted and that the La-200 would be the first to receive the new radar, Semyon A. Lavochkin suggested that a heavy aircraft but a faster one than the B-17 be used to bring the radar up to scratch. The IL-28 was the obvious choice.

To accommodate the radar the bomber's nose glazing was cut away at fuselage frame 2 and substituted by a cylindrical metal structure (part of the Yak-120's nose incorporating the avionics bay). The huge dish of the RP-6 was enclosed by a large glassfibre radome which had an almost hemispherical front end instead of the usual pointed or ogival shape. The conversion work was done by Lavochkin OKB specialists under the supervision of the Ilyushin OKB (which was not directly interested in the project but held responsibility for the IL-28 anyway).

The famous test pilot Mark L. Gallai flew the IL-28LL, with R. A. Razumov as test engineer; the latter was the worst off, sitting in a dark and extremely cramped bay aft of the radar set – all that remained of the navigator's station. A total of 33 flights were made without any problems; the test programme, which ended in December 1952, included simulated intercepts of real aircraft. Later, tests of the Sokol radar continued on the La-200B interceptor prototype which, after being rejected by the VVS, found use as a testbed. By the end of 1953 the radar had been perfected and was fitted to the late-production Yak-25M from 1954 onwards, replacing the RP-1D *Izum**rood*** (Emerald) radar fitted to early Yak-25s *sans suffixe* as a stopgap measure.

Missile targeting systems research aircraft: In 1960 the Ministry of Defence's Central Research Institute No.30 (TsNII-30 – *Tsen**trahl**'nyy naa**och**no-is**sled**ovatel'skiy insti**toot***) joined forces with NII-2 and the Research Institute of the State Committee for Electronics (NII GKRE – *Naa**och**no-is**sle**-dovatel'skiy insti**toot** Gosoo**dar**stvennovo komi**te**ta po **rah**dioelek**tro**nike*) to develop active radar homing systems for anti-shipping missiles. To this end it was necessary to analyse the characteristics of the radar pulse reflected from surface ships. Thus an IL-28 and a Lisunov Li-2 (a licence-built Douglas DC-3 derivative) were converted into avionics testbeds equipped with two experimental radars and special recording equipment.

The measurement and recording system (MRS) developed by NII-2 was housed in the IL-28's bomb bay. It included a high-speed ciné camera capturing the radar pulses reflected from the ship and appearing as lines on the radar display. The two testbeds made more than 50 flights from Kirovskoye airbase on the Crimea Peninsula, using Black Sea Fleet cruisers, destroyers and minesweepers as targets. The ships were either anchored on the roadstead at Feodosiya or moved on predetermined headings. Measurements were made in 38 flights at 2,000-5,000 m (6,650-16,400 ft) and 110-167 m/sec (360-547 ft/sec) at 10 to 50 km (5.4-27 nm) range.

43 measurements were made with the cruisers, 64 with destroyers and 40 with minesweepers at various sighting angles in various sea state conditions. The results were analysed by a computer, which made it possible to develop algorithms for determining the class of a ship in a group; this helped to develop guidance systems for stand-off anti-shipping missiles.

An *IL-28U coded '18 Blue'* was apparently converted into an avionics testbed of some sort, sporting several non-standard aerials under the forward and rear fuselage. Unfortunately no details are known of this aircraft; it may have been a navaids calibration (flight checker) aircraft.

IL-28LL ejection seat testbed

The IL-28 was extensively used for research and development work. In the early 1960s several aircraft were converted into testbeds for various systems of the *Vos**tok*** (East) manned spacecraft under development by Sergey P. Korolyov's team. One of these was IL-28 '10 Blue' (c/n 53005710), an ejection seat testbed used to test, among other things, the ejection seat of the Vostok's re-entry capsule. Interestingly, this aircraft has likewise been referred to as IL-28LL.

The bulky Vostok ejection seat was installed in the faired-over bomb bay immediately ahead of the wing torsion box and protruded above the upper fuselage; hence a large teardrop fairing with flattened sides had to be installed aft of the pilot's cockpit to protect the test pilot sitting in the seat from the slipstream. Additionally, the tail gunner's compartment was replaced by a large slab-sided fairing extending much further aft, from which another ejection seat could be fired both upwards and downwards. Ciné cameras were mounted in fairings above and below the wingtips to capture the ejection sequence.

The Vostok ejection seat was tested successfully by future cosmonaut Gherman Titov. The Mikoyan SM-50 fighter (aka MiG-19SU, an experimental version of the MiG-19SF with a ventral U-19 liquid-propellant rocket booster) acted as chase plane and camera ship.

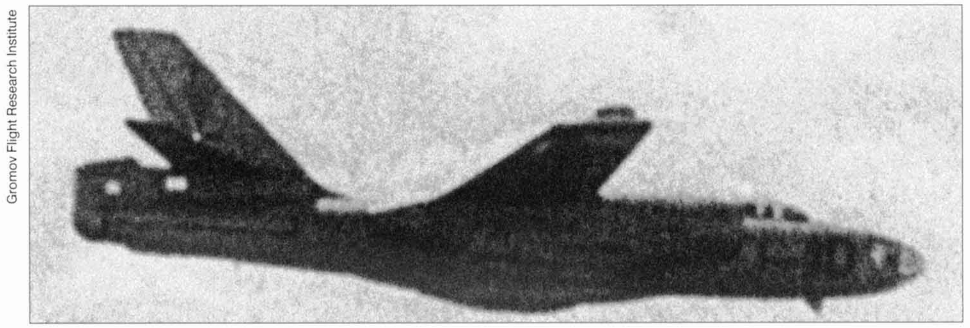
In-flight refuelling system testbeds

Fighter IFR system integration: A Voronezh-built IL-28 ('01 Red', c/n 2402101) was converted into a makeshift 'tanker trainer' used for testing the hose-and-drogue flight refuelling system developed by OKB-918 led by Guy Il'yich Severin. (Later known as the Zvezda (Star) Joint-Stock Company, this OKB also developed the UPAZ-1A Sakhalin refuelling pod used on the IL-78/IL-78M tanker (see Chapter 4) but is best known for its K-36 ejection seat.)

The aircraft worked with the tenth production Gor'kiy-built MiG-19 coded '10 Red' (c/n 59210110) converted at LII in late 1957. This fighter had no fewer than four dummy refuelling probes (one ahead of the windshield and three on the port wing) because the best location for the probe had to be determined experimentally.

An experimental winch emulating a hose drum unit (HDU) was installed in the IL-28's bomb bay, paying out a 5-mm (0.19-in) steel cable with a drogue of 640 mm (2 ft 1.19 in) diameter to a point 42 m (137 ft) beyond the bomber's tail. Initially a 36-kg (79-lb) unstabilised drogue was used. After the first four flights, however, it was replaced with a drogue incorporating a stabilising device 100 mm (3.93 in) wide mounted at 60 mm (2⅜ in) from the base. Both models had a lock for engaging the probe.

The MiG-19 would make contact with the tanker at 7,000 m (22,965 ft) and 450-470 km/h (279-292 mph) indicated airspeed, approaching from a stand-by position 10-20 m (32-65 ft) behind the drogue. Contact was usually made in a climb, with or without side slip. Approach speed varied from 0.3 to 12 m/sec (1-39 ft/sec) or 1-30 km/h (0.62-18.6 mph) IAS. After making contact the MiG-19 stayed locked into the drogue for 3-5 seconds, then slowed down and broke contact. For safety's sake the drogue lock was set at an unlocking force of 60-80 kg (130-180 lb). Usually the fighter carried drop tanks to increase mission time.



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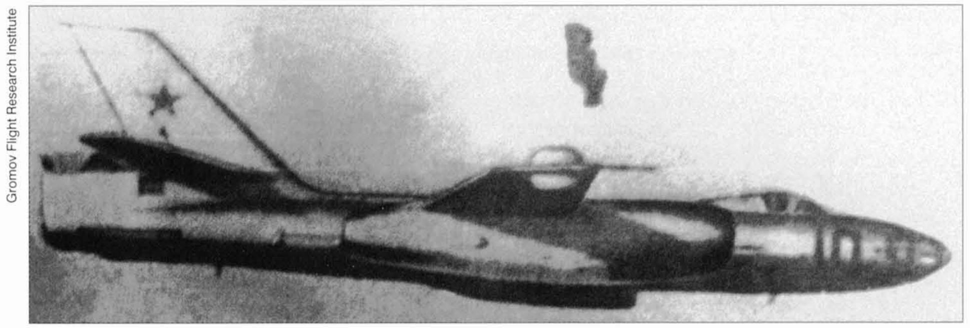
Above: The IL-28LL ejection seat testbed operated by LII ('10 Blue', c/n 53005710) with the rear test cabin apparently faired over from above.



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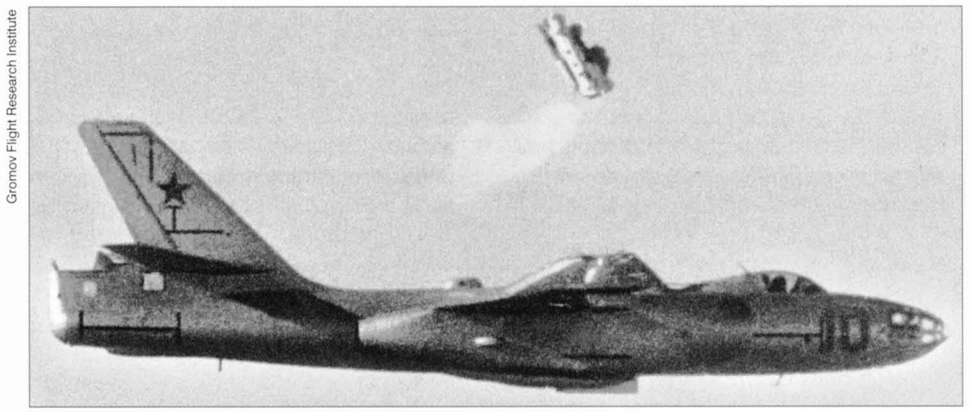
Above: This heavily retouched photo shows what looks like an ordinary ejection seat fired from the forward test compartment of IL-28LL '10 Blue'. Note the faired ciné cameras above and below the wingtips.



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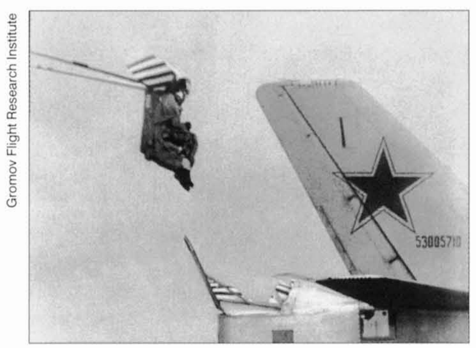
Above: A test of the ejection seat developed for the Vostok spacecraft. Note the dorsal 'hump', the ventral blast doors in line with it, the different design of the rear test cabin and the photo calibration markings.



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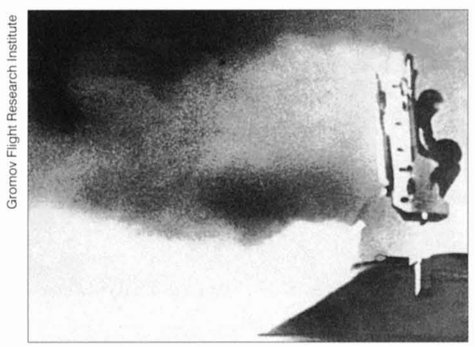
What looks like the Zvezda K-36 seat is fired through the canopy of the rear cabin. Note the stabilising booms extending from the headrest.



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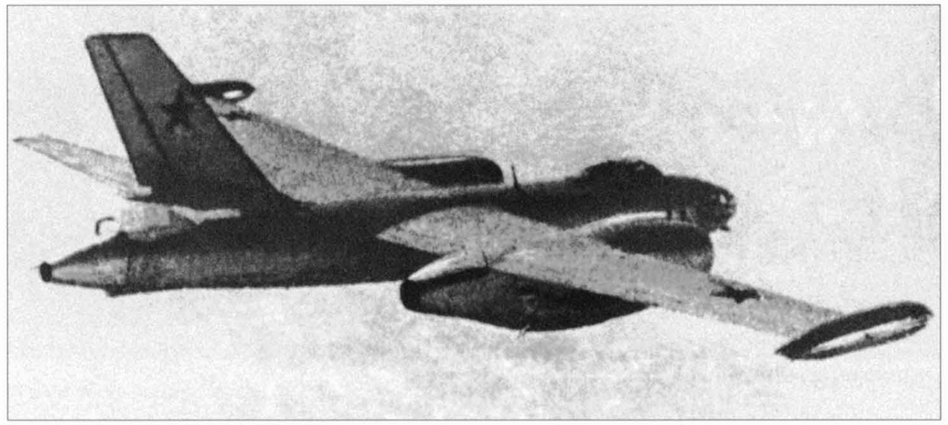
The Vostok ejection seat spouts terrific flames as it leaves the dorsal fairing of the IL-28LL.

Test pilot Nikolai O. Goryaynov (who has the distinction of being the first Soviet pilot to successfully refuel a heavy bomber in flight) was assigned project test pilot for the 'tanker trainer'. On 28th August 1957 he made a flight to check the operation of the winch. The drogue was deployed at 7,000 m (22,965 ft) and 400, 450, 500 and 550 km/h (248, 279, 310 and 341 mph) IAS. After that, test pilots S. F. Mashkovskiy, Pyotr I. Kaz'min and Sergey N. Anokhin made ten 'refuelling' sorties.The tenth flight had to be cut short

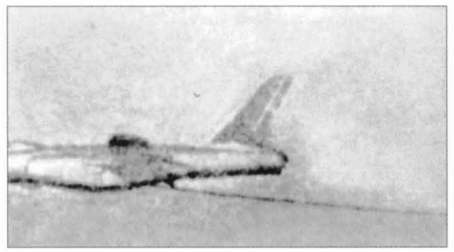


Yefim Gordon archive

Above: This IL-28R served as a testbed for a liquid-fuel rocket motor developed by L. S. Dooshkin.

when the drogue entered the fighter's air intake and collapsed, the debris damaging one of the engines. The trials showed that the chances of making contact with the tanker depended mainly on the drogue's stability which left much to be desired, as the drogue twisted crazily in the slipstream.

Bomber IFR system tests: In due course the Soviet military put forward more stringent requirements which the IL-28 could no longer meet. One of the greatest deficiencies was the bomber's inadequate range. However, at that stage it was deemed inadvisable to retire the many IL-28s in VVS service, so someone suggested retrofitting the bombers with the probe-and-drogue refuelling system. To this end two more IL-28s were converted for real-life IFR system tests.



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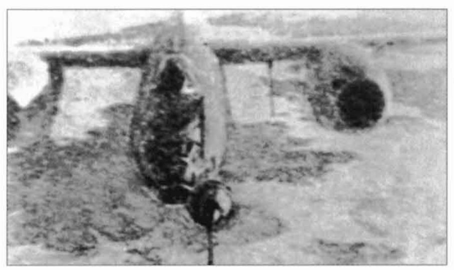

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Three stills from a ciné film showing the two IL-28s modified for probe-and-drogue IFR system trials.

One of them was a tanker with a real HDU in the bomb bay, while the other *Beagle* featured a fixed refuelling probe offset to port above the navigator's station. The two aircraft made successful contacts but the system was not fitted to IL-28s because Aleksandr S. Yakovlev's OKB-115 brought out the more promising Yak-129 supersonic tactical bomber which entered production and service as the Yak-28 *Brewer*.

Landing gear testbeds

IL-28LSh: In 1958 a Moscow-built IL-28 coded '12 Red' (c/n 53005112) was converted into the IL-28LSh testbed (LSh = ***lyzh**noye **sh**assee* – ski landing gear) for testing the efficacy and durability of aircraft skis designed for dirt strips. The aircraft was fitted with a semi-retractable sprung skid under the centre fuselage. The skid was equipped with pressure sensors and mounted on a hollow box which could be filled with ballast to test it for various loads; the whole assembly could be raised and lowered by hydraulic rams. The nose gear unit was fitted with larger wheels and the main units had widely-spaced twin wheels rather than the usual single ones. This modified undercarriage could not be retracted, so the mainwheel well doors were deleted to avoid fouling the wheels. The skid was tested on airstrips with various soil density; the aircraft made high-speed runs but did not become airborne.

Tracked landing gear testbed: To enhance the *Beagle*'s ability to operate from tactical airfields a special tracked landing gear was designed, built and tested on an IL-28 pursuant to a Council of Ministers directive of 11th January 1951. It allowed the bomber to operate from soft, wet, soggy or snow-covered airfields which rendered take-off with a conventional wheeled landing gear was very difficult or utterly impossible. The tests were considered successful but, owing to the extra weight and complexity of the experimental landing gear, it was not retrofitted to production aircraft.

Engine testbeds (and more)

Soviet testbed: One IL-28R (c/n unknown) was modified to test a liquid-propellant rocket motor developed by L. S. Dooshkin. The experimental powerplant was installed in a short fairing shaped like a cropped cone supplanting the gunner's station. The tests took place in 1953-57.

East German testbeds: Few remember nowadays that East Germany had an aircraft industry of its own. Besides building the IL-14P airliner under licence in Dresden, the Germans designed their own aircraft as well. In the early 1950s Brunolf Baade started work on the '152' – a 72-seat medium-haul airliner powered by four indigenous Pirna 014 axial-flow turbojets rated at 3,150 kgp (6,940 lbst).

Incidentally, Western publications often call this aircraft BB 152 or VEB-152; however, (former) East German sources invariably refer to the aircraft simply as the 152. In fact, the prototypes should have been designated EF 152 (for *Entwicklungsflugzeug* – development aircraft), in keeping with the traditions of Junkers AG where Baade had once worked, but this designation was not taken up.

Design work on the engine commenced in 1955, and the prototype was bench-run a year later. As the flight test stage approached, VEB Entwicklungsbau Pirna (Pirna Development & Manufacturing) at Pirna-Sonnenstein bought an IL-28R (c/n 1418) and converted it into an engine testbed. The reconnaissance version was chosen because of the stronger landing gear – a useful feature since the engine alone, not including the test instrumentation, weighed 1,060 kg (2,340 lb). The aircraft was delivered *sans* radar and armament and registered DM-ZZI. Curiously, the aircraft carried the West German flag on the fin – for some obscure reason the elaborate coat of arms placed in the centre of the otherwise identical East German flag had been omitted.

The experimental engine was housed in a large nacelle under the centre fuselage (called *Tropfen*, 'drop [of water]', in local slang); the bomb bay doors were faired over. To prevent FOD on take-off/landing and windmilling during cruise the air intake was closed by a hydraulically-actuated shutter which the test engineer could open or close by means of a hand-driven pump at up to 350 km/h (217 mph). The lower lip of the intake was flattened, resulting in a shape not unlike that of the Boeing 737-300/-400/-500; this was probably caused by the shape of the shutter rather than by inlet aerodynamics. The lower aft fuselage was covered with some kind of heat-resistant gunk to protect it from the jet blast.

Right: The IL-28LSh ('12 Red', c/n 53005112) was used to investigate the efficacy of a skid landing gear that would enable tactical aircraft to operate from soggy strips.

Below right: The skid was installed on a box attached to the the fuselage by parallel sets of trailing arms and raised or lowered as required by a hydraulic ram. Note the twin wheels on the main gear units to prevent the aircraft from sinking into the mud on waterlogged strips; the landing gear was non-retractable and all gear doors were removed. The white object aft of the nosewheel well appears to be a ciné camera 'egg'.

Centre right: Close-up of the box which could be filled with ballast to simulate various loads. Note the skid's shock absorber.

Bottom: The IL-28LSh in action. Note the wide-track nosewheels and nose gear bracing struts.

The bomb bay housed test instrumentation – a priming tank, a data recorder, an instrument panel and an AK 8 or AK 16 remote-controlled ciné camera (or a still camera) with appropriate lighting to film the instrument readings. The navigator was exiled to the gunner's cabin from which he kept an eye on the test engine via forward-view mirrors under the tailplanes, watching out for a possible fire, fuel leaks and the like. The regular navigator's compartment housed the test engineer, the Pirna 014's controls and more instruments. One of the fuel cells had to be removed, but the wingtip fuel tanks made up for this.

The first flight-cleared engine (the Pirna 014 V-9; V = *Versuchsmuster* – test article or development aircraft) was fitted to DM-ZZI in 1959. For ground runs, the aircraft was wheeled on to special elevated supports to minimise FOD risk. Finally, on 11th September the aircraft made its first test flight from Dresden-Klotzsche airport (which was also the home of VEB Flugzeugbau Dresden and a major air force base).

The test programme included performance testing at altitudes up to 12,500 m (41,010 ft) in 500-m (1,640-ft) increments and speeds up to Mach 0.78. Flight idling RPM and windmilling RPM at various speeds and altitudes were determined, relight possibilities at up to 12,000 m (39,370 ft) and the inclination to surge in different flight conditions were checked, icing tests and ground noise level measurements were made.

Performance and handling differed little from those of a standard IL-28, except that with the test engine running at full power the aircraft's rate of climb increased to 35 m/sec (6,890 ft/min).

DM-ZZI made a total of 109 test flights; the last flight took place on 22nd February 1961 with a production-standard Pirna 014A-1 built at Ludwigsfelde. However, the test programme was taking rather longer than anticipated, so another IL-28R (c/n

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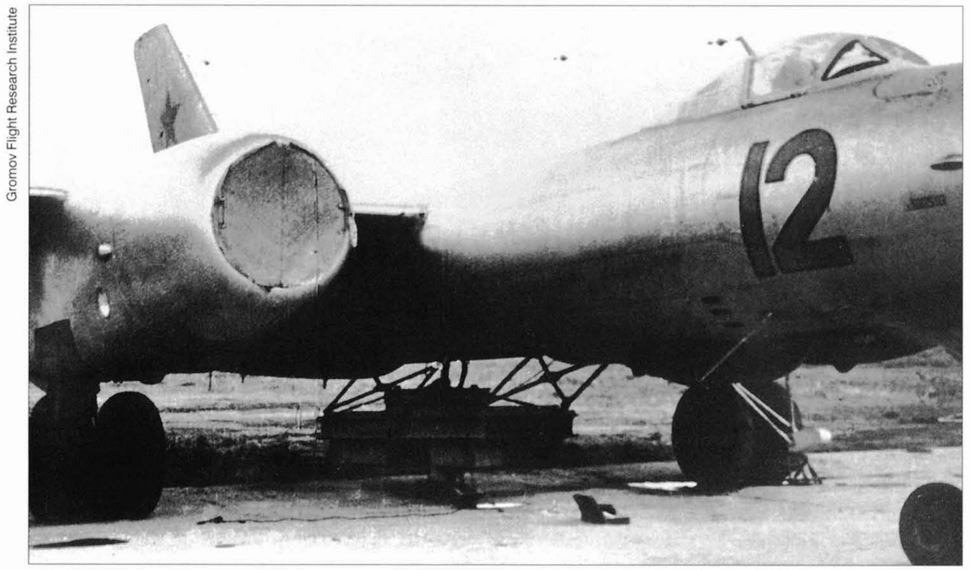

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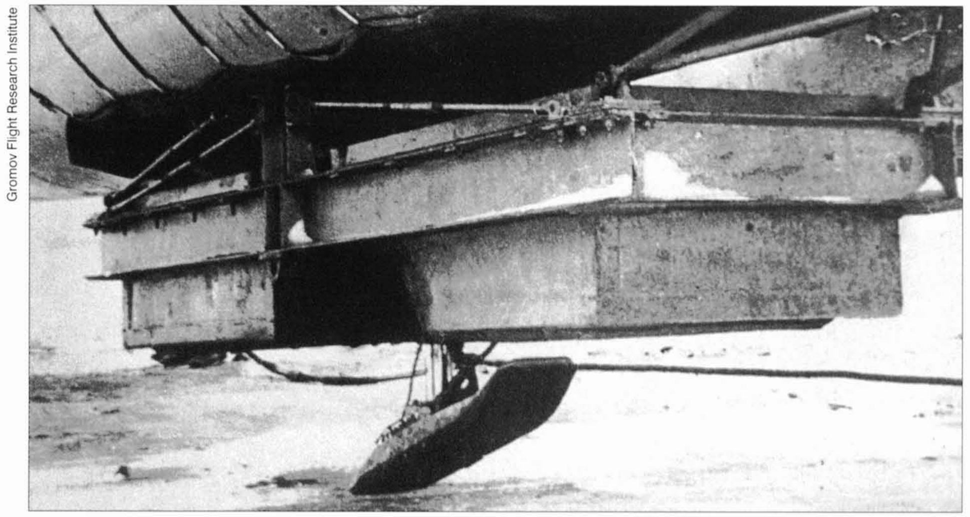

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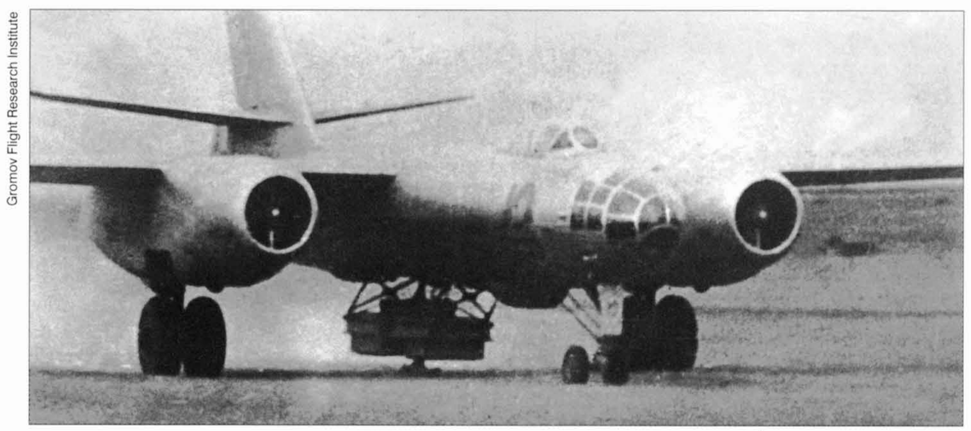

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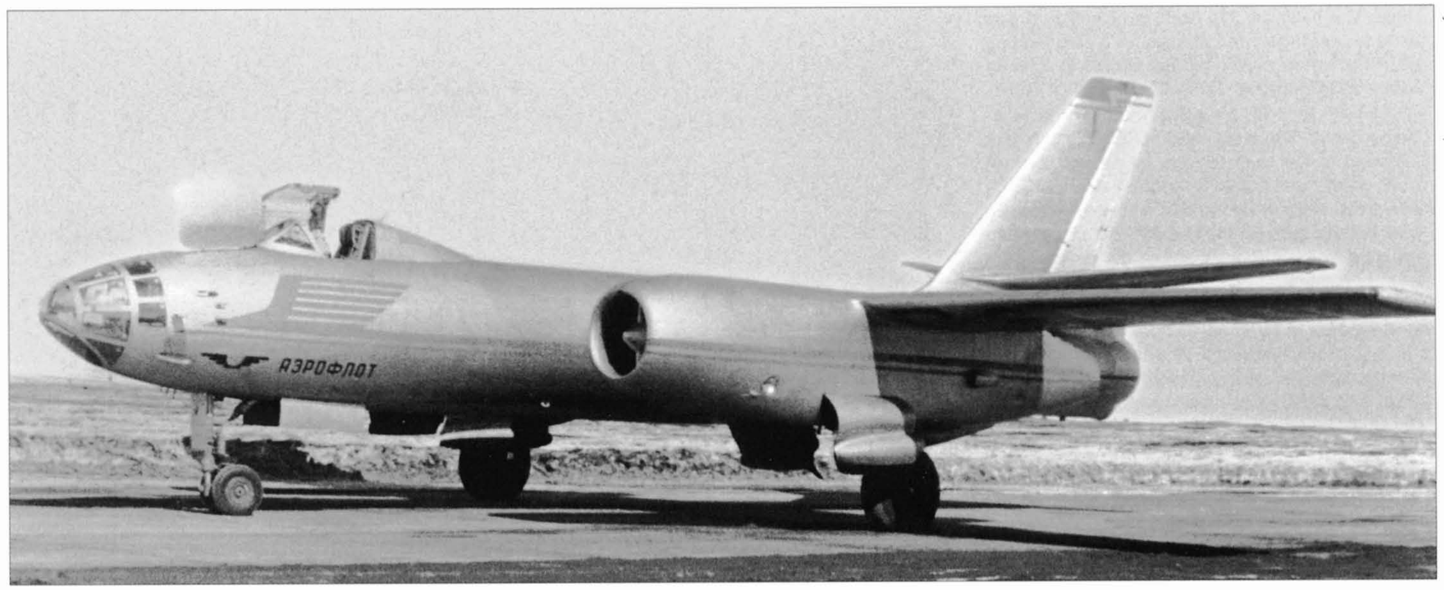


Ilyushin Aviation Complex

Above: In the mid-1950s/early 1960s the Soviet airline Aeroflot operated a handful of demilitarised IL-28s under the designation IL-20 (IL-28P) as fast mailplanes and pilot trainers during the Tu-104 airliner's service introduction period. This is an example with the post-1958 registration CCCP-36584; note the red cheatline with 'feathers' and the bi-colour Aeroflot logo with blue wings and red hammer-and-sickle. Curiously, none of the IL-20s carried the Soviet flag on the tail.

5901207) was converted into an identical testbed registered DM-ZZK to speed up the tests. This aircraft made 102 flights between 26th February 1960 and 12th June 1961 (the last flight was with Pirna 014 V-28). Other examples of the engine installed on the two aircraft included Pirna 014 V-20 (the first Pirna 014A-1) and Pirna 014 V-22.

Meanwhile, the 152 V-1 (DM-ZYA) was rolled out in Dresden on 30th April 1958. On 4th December the aircraft made its first flight, powered by Mikulin RD-9B turbojets, since no flight-cleared Pirna 014 engines were available yet. Three months later, on 4th March 1959, the first prototype crashed due to a fuel system defect, killing the crew. The much-modified second prototype (152 V-4, DM-ZYB) powered by Pirna 014A-1 engines flew on 26th August 1960; the defect was soon discovered during defuelling tests and could be easily rectified. The third prototype (DM-ZYC) was completed in due course and the first 28 production aircraft were in various stages of completion.

Then the East German government lowered the boom. It had long considered the local aircraft industry unprofitable, and in late November 1960 it was decided to eliminate the industry altogether. Big Brother would supply East Germany with all the aircraft she needed anyway. And by mid-1961 the 152 (and hence the Pirna 014) was abandoned. DM-ZZI and DM-ZZK were reconverted to IL-28R standard and delivered to the East German Air Force as '180 Black' and '184 Black' respectively on 1st November 1961 for use as target tugs. The navigator's station was reinstated but the armament and radar were still missing.

Czech engine/parachute testbed: A Czech Air Force IL-28 (Avia B-228) serialled 6915 (c/n 56915) was converted into an engine testbed by the Walter company (later named Motorlet) in June 1960. Originally it served to test the 890-kgp (1,960-lbst) Walter M-701 turbojet developed for the Aero L-29 Delfin advanced trainer. The centrifugal-flow turbojet was rather too portly to fit under the IL-28's fuselage, so a rather unorthodox installation was chosen – the engine was mounted in an ogival fairing instead of the tail turret, breathing through a ventral 'elephant's ear' air intake. The bomb bay was occupied by test instrumentation.

ITAR-TASS

Aeroflot personnel carry sacks of mail from IL-20 with the pre-1958 style civil registration CCCP-Л5402 (ie, SSSR-L5402, c/n 54005777). Typical of the early days of the IL-20's service career, this aircraft retains the overall silver finish it wore in its Air Force days.

Later the same machine was used to test the 1,500-kgp (3,310-lbst) AI-25TL turbofan in a recontoured and more elongated fairing. This Soviet engine designed by OKB-478 under Aleksey G. Ivchenko powered the Aero L-39 Albatros advanced trainer (the licence-built version was sometimes referred to as the Walter Titan). The engine and associated equipment were subsequently removed but for some obscure reason the long fairing was retained, though the air intake and nozzle were faired over. In this configuration the aircraft was used to test new models of parachutes by dropping dummies filled with sand.

IL-28H: The type did some development work in Poland as well. One IL-28 serialled '119 Blue' was transferred to the Instytut Lotnictwa (Aviation Institute) in Warsaw and converted into an engine testbed designated IL-28H (*hamownia* – test rig or, in this case, testbed). It was used to test the indigenous 1,000-kgp (2,205-lbst) PZL-Rzeszów SO-1 axial-flow turbojet (SO = *silnik odrzutowy* – jet engine) developed for the PZL TS-11 Iskra (Spark) advanced trainer.

The engine was installed on a special mount and was semi-recessed in the open bomb bay when on the ground. It was lowered clear of the fuselage by hydraulic rams before startup; for ground runs the aircraft was parked over a special trench. The experimental engine's controls were installed in the navigator's compartment where the test engineer sat. The test programme was successfully completed in the spring of 1964. Later the IL-28H was used as a 'mother ship' for the indigenous Mak-30 remotely-piloted vehicle (RPV).

Parachute testbed

Two Polish Air Force IL-28, '001 Red' and '2 Red', were used by the Polish Air Force's Technical Institute (ITWL – *Instytut Techniczny Wojsk Lotniczych*) to test the PB-28 brake parachute with a 7-m (23-ft) diameter.

IL-20 (IL-28P) mailplane

The *Beagle* had a paw in the development of civil jet aviation in the Soviet Union as well. In order to familiarise pilots and ground personnel of Aeroflot (the sole Soviet airline) with jets, a few demilitarised IL-28 bombers and at least one IL-28U (c/n 64007417) were transferred to the airline. They were designated IL-20 (inheriting the designation of the attack aircraft described in Chapter 1) or IL-28P (*poch**tov**yy* [*samo-**lyot***] – mailplane).

Yefim Gordon archive

IL-20 CCCP-36588 (c/n 54006104) had a slightly different livery with a blue pinstripe below the cheatline.

The type was chosen carefully, as the IL-28 was easy to fly and service and posed no problems for Aeroflot crews flying IL-12 and Lisunov Li-2P (or Douglas C-47 Dakota) airliners. The IL-28's high speed, long range and modern (in its day) avionics allowed the crews to quickly master jet aircraft flying techniques and eased the subsequent transition to the big jets. The aircraft's good field performance enabled it to use most of the Soviet Union's civil airports.

The first group of Aeroflot flight crews started conversion training for the IL-20 in October 1953 and the type began carrying freight and mail in late 1954. The first examples were registered CCCP-Л5401 through CCCP-Л5406 (that is, SSSR-L5401 through SSSR-L5406); later IL-20s were registered CCCP-36580 through -36588 under the new system. The IL-20 was much used to deliver matrices of the *Pravda* and *Izvestiya* daily newspapers from Moscow to Irkutsk where both papers had additional print shops. If the papers were delivered all the way from Moscow they would be one day old by the time they reached the Far Eastern regions of the Soviet Union, and who wants yesterday's news? Together with the so-called Tu-104G (*groozo**voy*** – cargo, used attributively), which was really a demilitarised Tu-16 *Badger-A* bomber, the IL-20 enabled Aeroflot to develop a training programme which greatly speeded up the introduction of the first Soviet jet airliner, the Tu-104.

(Note: Under the Soviet civil aircraft registration system used in 1922-1958 the CCCP- country prefix was followed by a letter designating the agency to which a particular aircraft was assigned, plus up to four figures. Thus, the L designator (for *lee-**ney**nyy* [*samo**lyot***] – aircraft in airline service) denoted the Main Directorate of the Civil Air Fleet (GU GVF – ***Glah**vnoye oopravle-niye grazh**dahn**skovo vozdooshnovo **flot**a*) which operated scheduled passenger or cargo services. By comparison, CCCP-Hxxx (the Cyrillic N) stood for the Main Directorate of the Northern Sea Route (GU SMP – ***Glah**vnoye oopravleniye **sev**ernovo mor-**skov**o pu**tee***) which included the Polar Aviation branch, CCCP-Cxxxx (the Cyrillic S) for the Osoaviakhim sports organisation running Soviet air clubs, CCCP-Axxxx for the agricultural division, CCCP-Kxxx (derived from ***kras**nyy krest* – red cross) for ambulance aircraft etc. The rendering of the registrations as actually applied is used throughout.)

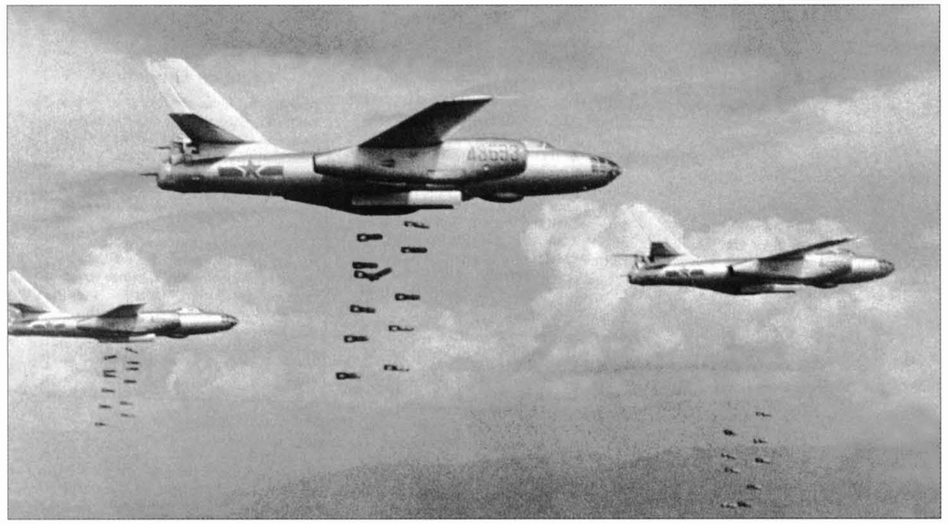
Foreign production

Chinese production

As it did with many Soviet types, China built the IL-28 – without the benefit of a licence. This 'piracy' began after the rift in Sino-Soviet relations over ideological differences in the mid-1960s which put an end to new aircraft deliveries from the USSR. Since China had no indigenous tactical bomber, there was no option but to copy a Soviet design.

In 1964 the aircraft factory in Harbin started manufacturing spare parts for the Soviet-built IL-28s operated by the Chinese air arm. This logically led to the production of complete aircraft; construction of the first two airframes – the 'prototype' and a static test airframe – also began in 1964 and the first locally-manufactured IL-28 took to the air on 25th September 1966, flown by pilot

China Aircraft



Above: A trio of Chinese People's Liberation Army Air Force H-5s drops bombs during an exercise. Note the different tail turret.

Wang Wenying, navigator Zhang Huichang and radio operator Zeng Fannan. Full-scale production at Harbin commenced the following year. Chinese-built Beagles were designated H-5 (*hongzhaji* – bomber) or B-5 (B = bomber) for export.

To be perfectly honest, the Chinese did not adopt a simple copycat approach and altered the bomber considerably, changing up to 40% of the design. In particular, the H-5 had a different (conventional) wing design without the IL-28's trademark feature (the technological break along the chord line); this saved some 110 kg (240 lb) of weight, albeit the manufacturing process became more difficult.

Outwardly the Chinese reverse-engineered 'chow-chow' can be distinguished from the genuine Soviet-built *Beagle* mainly by the shape of the rear extremity of the fuselage. The original IL-K6 'ball' turret was replaced by the DK-7 turret mounting two Afanas'yev/Makarov AM-23 cannons with 500 rpg. This turret was borrowed from the Tu-16 bomber; it is of basically cylindrical shape, not spherical. Also, the cockpit canopy has a one-piece blown transparency (without the lengthwise frame member), a taxi light is built into the forward door of the nosewheel well (a feature not found on most Soviet-built Beagles) and the starboard forward-firing cannon is deleted.

A tactical nuclear strike version similar to the Soviet IL-28A was developed in September 1967. The first test drop of a nuclear bomb from such an aircraft took place on 25th (or 27th?) December 1968.

The IL-28U was also manufactured in Harbin as the HJ-5 (*hongzhaji jiaolianji* – bomber trainer) or BT-5 (bomber trainer), making its 'second first flight' on 12th December 1970. It was officially phased in by the People's Liberation Army Air Force (PLAAF) in 1972 and a total of 187 were built.

The Chinese also brought out torpedo bomber and PHOTINT versions of the H-5; the Chinese equivalent of the IL-28R was developed in 1970, bearing the designation HZ-5 (*hongzhaji zhenchaji* – bomber/reconnaissance aircraft) for the "home market" or B-5R for export. The aircraft was equipped with two cameras for day/night high-altitude photography. Unlike the Soviet reconnaissance version, the HZ-5 had underwing drop tanks instead of tip tanks; these extended range by 47%, the combat radius by 50% and endurance by 1 hour 23 minutes. Development of the PHOTINT version was rather protracted and the aircraft was not officially included into the PLAAF inventory until 1977.

RART

Above: Czechoslovak Air Force Avia B-228s taxi out for a training sortie. The soot on the nose of AD-31 (a result of firing the nose cannon) has been scrubbed away, but only just enough to make the serial readable!

RART

A pristine B-228 in pre-1957 markings. The alphanumeric serials on the nose later gave way to four-digit serials on the rear fuselage matching the last four digits of the c/n.

Czech production

Czechoslovakia, too, built the IL-28, albeit in much smaller numbers; in this case a licence had been obtained. Again. licence production was undertaken by Avia. As already mentioned, until the 1950s the Czech Air Force had a habit of giving its own designations to foreign military aircraft built in Czechoslovakia. Thus the *Beagle* was built locally as the B-228 (for *bombardovací* [*letoun*] – bomber), while the licence-built version of the IL-28U trainer was designated CB-228 (for *cvicny bombardovací* [*letoun*] – bomber trainer).

By the mid-1950s, the general operational requirements to tactical bombers had become much more stringent, rendering the subsonic IL-28 obsolete. Therefore, on 3rd February 1956 the USSR Council of Ministers issued a directive to the effect that production of the IL-28 be stopped. By then, as already mentioned, 6,316 aircraft had rolled off the assembly lines in the USSR; the IL-28 surpassed all other Soviet jet bombers in terms of production.

The importance of the IL-28 in the development of the Soviet Air Force can hardly be played down. To the VVS and the air forces of 'friendly' nations it was what the English Electric Canberra was to the West, which gave rise to the nickname 'Soviet Canberra' – albeit much later when the IL-28 was 'dead and buried'. The Canberra, however, was clearly luckier than its Soviet counterpart, soldiering on well into the 1980s (mostly in the reconnaissance and target tug roles), and the last survivors remain operational as of this writing.

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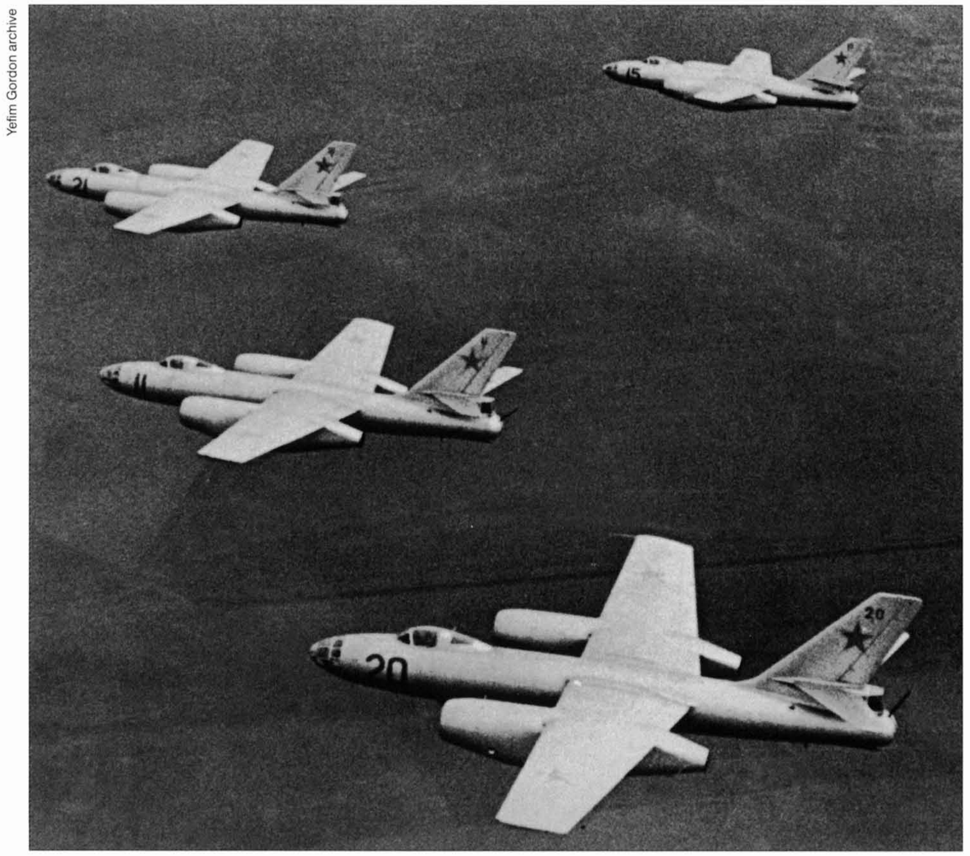

A formation of IL-28s cruises over typically flat East European countryside during a military exercise.

The IL-28 in Service

The advent of the IL-28 signified the beginning of the jet age for the Soviet tactical bomber force. As already mentioned, a bomber unit of the Moscow Defence District commanded by Lt. Col. A. A. Anpilov was the first to take delivery of the IL-28 in 1950.

The VVS bomber units re-equipped with the Beagle by the mid-1950s. Of course, the units and formations stationed in the western defence districts of the USSR which were closest to the potential adversary enjoyed priority in this respect

The IL-28 introduced radar and gave nuclear capability to the tactical bomber force – a feature which was particularly welcome during the Cold War years. Once it had become fully operational – that is, the crews learned to fly in poor weather conditions and at extreme altitudes (breaking through cloud cover during climb and descent), use radar and synchronised optical sights for bomb-aiming and use the defensive armament effectively – Soviet tactical air power received a major boost.

The IL-28 contributed a lot to the development of Soviet free-fall nuclear weapons. As already mentioned, the Beagle was used to test the RDS-4 nuclear bomb which then became the standard weapon of the IL-28N and the bomber versions of the Yak-28. On 3rd August 1953 a specially modified IL-28 dropped the first Soviet hydrogen bomb at the Semipalatinsk proving ground. On 12th August two IL-28s operating from Zhana-Semey AB monitored the test of the first Soviet neutron bomb performed under the guidance of Igor' V. Kurchatov, the Soviet counterpart of Samuel Cohen.

The AVMF started receiving the *Beagle* in the summer of 1951, initially in basic bomber configuration. The Black Sea Fleet's 943rd MTAP and the Red Banner Baltic Fleet's 1531st MTAP were the first naval units to receive the type. The North Fleet did not follow suit until 1953, the 574th MTAP being the first IL-28 operator there. Later, as already mentioned, the naval bombers were converted to carry one RAT-52 torpedo; this version was phased in by the AVMF in early 1953.

The outbreak of the Korean War put an end to post-Second World War arms reductions. The Soviet anti-shipping force started growing rapidly due to both formation of new units and the transfer of complete bomber regiments from the Air Force to the Navy; soon the AVMF had up to 20 torpedo-bomber units.

Soon after the IL-28 had become operational with first-line bomber units the Soviet Air Force's flying schools also started taking delivery of the type. These included the Tambov Higher Military Pilot School named after the famous record-setting female pilot Marina Raskova (TVVAUL – *Tam**bov**skoye **vys**sheye **v**oy**en**noye aviatsi**on**noye oo**chi**-lishche **lyot**chikov*), the Slavgorod branch of the Omsk Military Pilot School and the Nikolayev Minelayer and Torpedo-Bomber Flying School.

The IL-28 was popular with its crews and technical staff, and with good reason, too. The aircraft was easy to fly and operate, adequately armed and had a good safety and reliability record, once the learning curve had been overcome. Pilots accustomed to the spartan conditions of the Tu-2 with its cold and noisy cockpits were amazed by the comfortable and well-equipped cockpits of the *Beagle*. They were also quick to appreciate the IL-28's speed, rate of climb and good manoeuvrability. The tech staff, too, liked the IL-28 for its ease of access to the engines and all equipment items requiring maintenance in day-to-day service.

The IL-28's sturdiness and reliability soon became legendary. The VK-1 engine earned particularly high praise. Low-level missions were the order of the day, and quite often IL-28s ingested birds or clipped treetops during such missions, 'eating' branches; still, the engines usually kept running as if nothing had happened!

New efficient combat tactics were developed for the type, since the IL-28 was introduced when the Cold War was at its peak and was expected to turn hot any moment. IL-28 crews practised night flying and close-formation flying in flights, squadrons and regiments; the distance between aircraft in a flight did not exceed 40 m (130 ft) and the distance between flights in a regiment did not exceed 80 m (260 ft).

Penetrating enemy air defences was an important aspect of the IL-28 crews' combat training programme. Mock combat with Mikoyan/Gurevich MiG-15s and MiG-17s impersonating enemy fighters showed that a fighter armed solely with cannons had no chances against the *Beagle*. In a head-on

attack the bomber's high speed caused the fighter to close on the target at an enormous rate, leaving the fighter pilot little time to take aim (quite apart from the fact that the IL-28 had a pair of forward-firing cannons with which to discourage such attacks). In the rear hemisphere the bomber's effective tail turret and high manoeuvrability enabled the crew to successfully repel the fighters.

In the event of war the tactical scenario for the IL-28 units was approximately as follows. Each IL-28 carrying a nuclear bomb would be accompanied by at least a squadron of sister aircraft tasked with the ECM and air defence distraction role. After taking off from Soviet territory the bomber formation would climb to 10,000 m (32,810 ft) in order to save fuel. Then, setting up an ECM barrier, the bombers descended to low altitude over Poland to avoid detection by the powerful surveillance radar in West Berlin – NATO's first line of defence; some of the aircraft left the formation, making deceptive manoeuvres to confuse the AD radar operators. The same tactic was used to get past the numerous Hawk, Nike Hercules and Nike Ajax anti-aircraft missile systems. Eventually the bomb-toting *Beagle* would be left all alone, pressing on towards the target at treetop level. Then it would climb sharply to 1,000 m (3,280 ft), allowing the navigator to make sure they were in the right place, whereupon the bomb was dropped and the aircraft headed back, descending to ultra-low level again as it did. The idea was that the IL-28's high speed would enable it to outrun the shock wave and the crew would be protected from the flash by special blinds.

Still, even if the bomber managed to get that far and deliver the bomb, it had virtually no chances of returning to base because, with all the evasive manoeuvres, it was sure to run out of fuel on the way home. To remedy this, auxiliary airfields were initially built in Poland and East Germany where the bombers were to make refuelling stops. Later, bomber units operating the IL-28 (including the nuclear-capable version) were stationed in some of the Warsaw Pact nations, which placed them within range of the south coast of England.

Yefim Gordon archive

Above: Flaps fully deployed, a Soviet Air Force IL-28 is seen seconds before touchdown.

ITAR-TASS

Soviet Navy airmen wearing leather jackets and 1950s-style white-topped caps receive the 'ready to fly' report from the crew chief. The rightmost man must be the navigator with his 'brainbag'.

While we are on the subject of Cold War warriors, the IL-28 actually played an important part in Operation *Mangoosta* (Mongoose) – an event which nearly started the Third World War. Forty-two nuclear-capable IL-28Ns were deployed to Cuba by sea in September 1962 together with a number of ballistic missiles. This was one of the reasons for the famous Cuban Missile Crisis of September-November 1962, when the USA enforced a naval blockade of Cuba, causing the Soviet Union in turn to dispatch a naval task force to the Caribbean.

The Soviet leaders had the common sense to back down and withdraw the missiles from Cuba in order to ease the situation. The bombers left in early December aboard the freighters S/S *Kasimov* (15 aircraft), S/S *Krasnograd* (15) and S/S *Okhotsk* (12). The aircraft were ostensibly arranged on the upper decks to show the Americans they were really being withdrawn, suffering heavy damage from the corrosive salt as a result.

As already mentioned, the IL-28 made its mark in the Naval Air Arm in the early 1950s; however, it was there that its obsolescence was most noticeable. By the mid-1950s the IL-28T did not meet the Soviet Navy's requirements any longer. Besides, the weapons cuts initiated by Khrushchov in 1960 and his general bias towards missiles dealt a severe blow to bomber aviation in general and naval bomber aviation in particular. All AVMF minelayer and torpedo-bomber units were disbanded, as were many tactical bomber units in the VVS, and many IL-28s were scrapped, even though some aircraft had only 60-100 hours' total time. This barbaric process went at an amazing rate, the work proceeding in three shifts. In the Pacific Fleet alone, about 400 aircraft were demolished within a very short period.

Fortunately the VVS command was not enthusiastic about this mayhem, and many IL-28s were simply placed in storage. Numerous *Beagles* were transferred to flying schools where they served alongside the IL-28U dedicated trainers until the mid-1980s. Others soldiered on as target tugs, also until the mid-1980s.

Moreover, the IL-28 got a new lease of life (if only briefly) in the late 1960s and early 1970s. A number of *Beagles* were converted to IL-28Sh ground attack aircraft.

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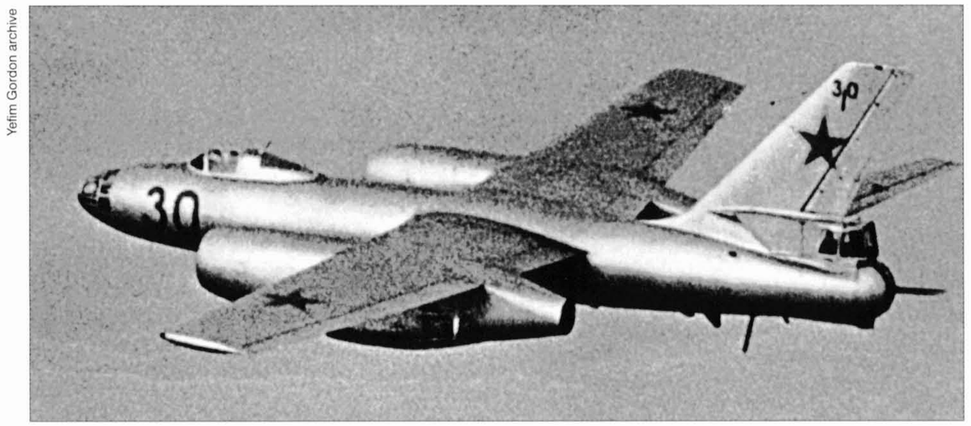
Above: A typical publicity shot of a group of IL-28s preparing for a training session at a wintry airbase. The second aircraft in the row has red-painted cowlings. Note the IL-28U at the far end of the flight line.



Yefim Gordon archive

This IL-28 features three non-standard aerials under the aft fuselage.

During the Korean War 70 IL-28s were deployed to People's Liberation Army Air Force (PLAAF) air bases in Manchuria. The aircraft wore PLAAF insignia but were flown by Soviet crews. It is not known if the bombers actually saw action in the war, but they did put in an appearance in North Korea. UN envoys monitoring prisoner-of-war exchanges reported Chinese bombers, including IL-28s, landing illegally at airbases near Pyongyang in direct violation of the truce agreement.

The *Beagle* did see action during China's last civil war when the Chinese Nationalists led by Chiang Kai-shek were driven from the continent to Taiwan. In early January 1956 PLAAF IL-28s bombed the Tachen islands 360 km (223 miles) north of Taiwan.

In the autumn of 1956 a large group of Soviet forces was deployed to Hungary to squash the anti-Communist uprising in this country. More than 120 IL-28s based in the Carpathian Defence District were placed on maximum alert duty, ready to launch strikes against the insurgents. Fortunately this never happened.

Another area where the IL-28 saw action in the autumn of 1956 is the Middle East. Egyptian Air Force (EAF) *Beagles* first saw action during the Suez Crisis (26th October to 7th November 1956).

By then the EAF had taken delivery of about fifty IL-28s but only one squadron operating 12 aircraft was fully combat-capable. Two other squadrons had only just been formed before the fighting began, and the crews had not yet mastered the new jet bombers. Consequently the IL-28 was used in the conflict on a small scale.

The EAF top commanders fully realised that, with no qualified crews to fly them, the bombers would be sitting ducks and a lucrative target for the Anglo-French strike force. Hence President Gamal Abdul Nasser ordered the EAF assets dispersed to remote bases or relocated to Syria and Saudi Arabia. Twenty IL-28s were flown to the Royal Saudi Air Force base at Riyadh by Soviet and Czech crews; the other 24 or 28 *Beagles* moved to Luxor, Egypt's southernmost airbase, where they were supposed to be safe. (This assumption turned out to be wrong, some IL-28s being lost subsequently as a result of British and French bombing raids).

In 1959 Chinese IL-28s saw action again when the government forces ruthlessly stamped out an ethnic minority uprising in the Tibet. Apart from that, the bombers were used in numerous skirmishes with the Taiwanese Nationalists – mostly over the Strait of Taiwan.

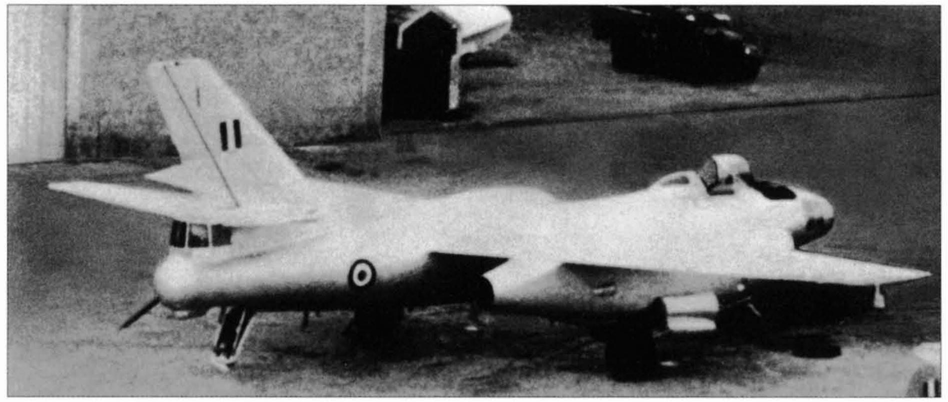
In November 1966 one Chinese IL-28 was delivered by its defecting crew into the hands of the Taiwanese Nationalists; the plane suffered minor damage during the landing. The Nationalists repaired and test flew the aircraft, then reportedly used it for reconnaissance flights over mainland China (some sources say the aircraft was handed over to the USA for close examination).

In 1962 Nasser sent his combat aircraft (including IL-28s) to Yemen, extending military aid to the Republicans who had overthrown the king. At the same time the Soviet Union also supported the Republicans, supplying them with a number of Beagles. The IL-28s attacked the Royalists' positions and flew reconnaissance sorties; the Western press reported that they were flown by both Yemeni and Soviet crews.

The IL-28 saw action in Africa as well. In April 1967 a coup d'état occurred in Nigeria, followed a month later by a new coup organised by Col. Ojukwu, governor of the Eastern province and one of the leaders of the Ibo tribe. The rebels declared their intention to secede, forming the so-called State of Biafra named after a bight in the Gulf of Guinea. This immediately sparked a bitter three-year civil war between the separatists and the federal government.

The Federal Nigerian Air Force (FNAF) obtained combat aircraft from Arab nations supporting the Islamic government in Lagos in its struggle against the Christian Ibo separatists. Egypt was the first to extend help, supplying 41 MiG-17Fs and, together with Algeria, six second-hand IL-28s in 1969. The bombers were flown by Egyptian mercenary crews. Operating from Enugu and Kalabar, the *Beagles* bore the brunt of the bombing missions but were reportedly found to be ineffective.

In 1967 there was trouble in the Middle East again when the third Arab-Israeli war, commonly referred to as the Six-Day War (5-10th June 1967), broke out. The Israeli high command developed a 'pre-emptive attack' plan known as the Moked Plan. On



RART

Above: A Federal Nigerian Air Force IL-28. This example retains the natural metal factory finish; most FNAF IL-28s wore crude green/black camouflage.

the morning of 5th June a massive assault was launched against Arab airbases. Among other things, 28 EAF IL-28s were destroyed on the ground at Ras-Banas AB and Luxor.

In February 1968 the IL-28 first put in an appearance in Vietnam when three *Beagles* were deployed to Fukien AB 30 km (18 miles) north-west of Hanoi. However, they did not participate in the Viet Cong offensives. In 1971 the North Vietnamese IL-28s did see action, supporting the Vietnamese People's Army and the Pathet Lao guerrillas in Laos.

Iraqi Air Force IL-28s were used operationally in the late 1960s and in the first six months of 1974 in Saddam Hussein's relentless war with the Kurdish minority living in the north of Iraq and striving for sovereignty. The Kurdish rebels claimed one bomber shot down in April 1974.

In the late 1970s the bloody regime of Pol Pot used a handful of IL-28s (or, more probably, Chinese-built H-5s) against the opposition forces headed by Heng Samrin who became head of the government after Pol Pot was ousted

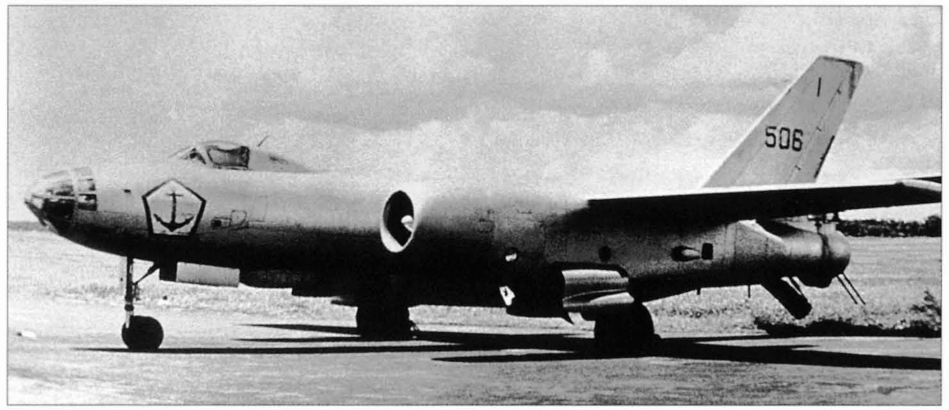
The Afghan War was the last conflict in which the venerable bomber participated. Despite its age, it turned out to be well suited for this war thanks to its rugged dependability in the harsh conditions of Afghanistan with its ill-equipped airfields and pervasive dust.

Some examples of the IL-28's use in foreign service have been mentioned above. To present a complete picture, the bomber was operated by the air forces and/or navies of Afghanistan, Albania, Algeria, Bulgaria, China, Czechoslovakia, East Germany, Egypt (United Arab Republic; Arab Republic of Egypt), Finland, Hungary, Indonesia, Iraq, Kampuchea, Morocco, Nigeria, North Korea, Pakistan, Poland, Romania, Somalia, Syria, Taiwan, Vietnam (North) and Yemen. The aircraft were supplied by the Soviet Union or China, or obtained secondhand from other sources.

The IL-28 has been aptly described by one Russian author as 'a successful design that was always out of luck'. Even though the IL-28's combat potential was not used to the full, it was this type that introduced jet aircraft and all-weather capability to the bomber element of the Soviet Air Force and several other air arms. The IL-28 helped to train hundreds of first-class naval pilots. Western aviation experts gave the *Beagle* due credit, describing it as a masterpiece of Soviet aircraft design.

The IL-28 – Structural description

The following description applies to the basic bomber version of the IL-28.



RART

506, an Indonesian Navy IL-28. The type was also operated by the Indonesian Air Force.

Type: Twin-engined tactical bomber. The crew comprises a pilot, a navigator/bomb-aimer and a tail gunner/radio operator.

The airframe is of all-metal construction and is made chiefly of D-16T duralumin, with flush riveting used throughout. AK6 aluminium alloy is used for the wing/fuselage attachment fittings and grade 30KhGSA steel for the tail unit/fuselage attachment fittings. The cockpit canopy, navigator's station and tail gunner's station glazing frames are ML5-TCh magnesium alloy castings, as are the frames of the navigator's and tail gunner's entrance hatches.

Fuselage: Circular-section stressed-skin semi-monocoque structure built in four sections for ease of assembly. The skin panels are 0.8-2.0 mm (0.03-0.78 in) thick and are supported by 50 frames (1 through 17, 17A, 18, 18A, 18B and 19 through 47), including 14 mainframes, and 38 stringers, 7 of which are reinforced. Maximum fuselage diameter between frames 17 and 20 is 1.8 m (5 ft 10⅞ in).

The *forward fuselage* (section F1, frames 1 through 11A) incorporates a pressurised cockpit (frames 6 through 11A) and a pressurised navigator's compartment (frames 0 through 6), both of which have sloping rear bulkheads. The navigator's compartment features extensive Plexiglas glazing, with an optically-flat Triplex lower forward panel 13-15 mm (0.51-0.59 in) thick. The entrance hatch (frames 3 through 6) located in front of the cockpit canopy is offset to starboard and hinged to port; the navigator's ejection seat is immediately below. For bomb-aiming by means of the optical sight the navigator uses a folding 'jump seat' attached to frame 2.

The cockpit canopy consists of a fixed windshield with an elliptical flat Triplex windscreen 13-15 mm (0.51-0.59 in) thick and two curved sidelights made of Plexiglas, and a rear section hinged to starboard with a two-piece blown Plexiglass transparency divided by a lengthwise frame member. The cockpit is equipped with a control column featuring a W-shaped control wheel, hinged rudder pedals, port and starboard consoles with throttles and other controls. The forward fuselage incorporates the nosewheel well (frames 4 through 11A) and the nose cannons' ammunition boxes (frames 7-8).

The ejection seats have back plates of 10-mm (0.39-in) steel armour and dished seat pans of 6-mm (0.23-in) steel. Additional duralumin armour sheets 10-30 mm (0.39-1.18 in) thick are installed under the navigator's seat. The navigator's glazing and the pilot's windshield do not incorporate bulletproof glass. The total weight of the armour is 454 kg (1,000 lb).

The *centre fuselage* (section F2, frames 11B through 38A) is unpressurised, incorporating the bomb bay (frames 18 through 29) and the avionics bay for the search radar (frames 11B through 16). It also accommodates the wing centre section (frames 23 through 27) and the fuel cells are located in the fuselage forward and aft of the wings. The bomb bay is closed by two pneumatically-actuated doors powered by the pneumatic system, with an emergency air bottle.

The *rear fuselage* (section F3, frames 38B through 42A) is also unpressurised, incorporating an avionics bay (with ventral access hatch) and tail unit attachment fittings located at frames 38, 40 and 42A. IL-28s built by Plant No.64 in Voronezh have sections F2 and F3 combined into a single whole, so that the fuselage is built in three sections with manufacturing joints at frames 11 and 42.

The *aft fuselage* (section F4, frames 42B through 47) is the tail gunner/radio operator's pressurised cabin accessed from below via a forward-opening hatch located between frames 42B and 45. The tail turret is mounted on frame 47. The gunner's station has a 106-mm (4.17-in) bulletproof rear window and 68-mm (2.67-in) bulletproof side windows; additionally, the gunner and the ammunition boxes of the IL-K6 turret are protected by 8-mm (0.31-in) steel armour.

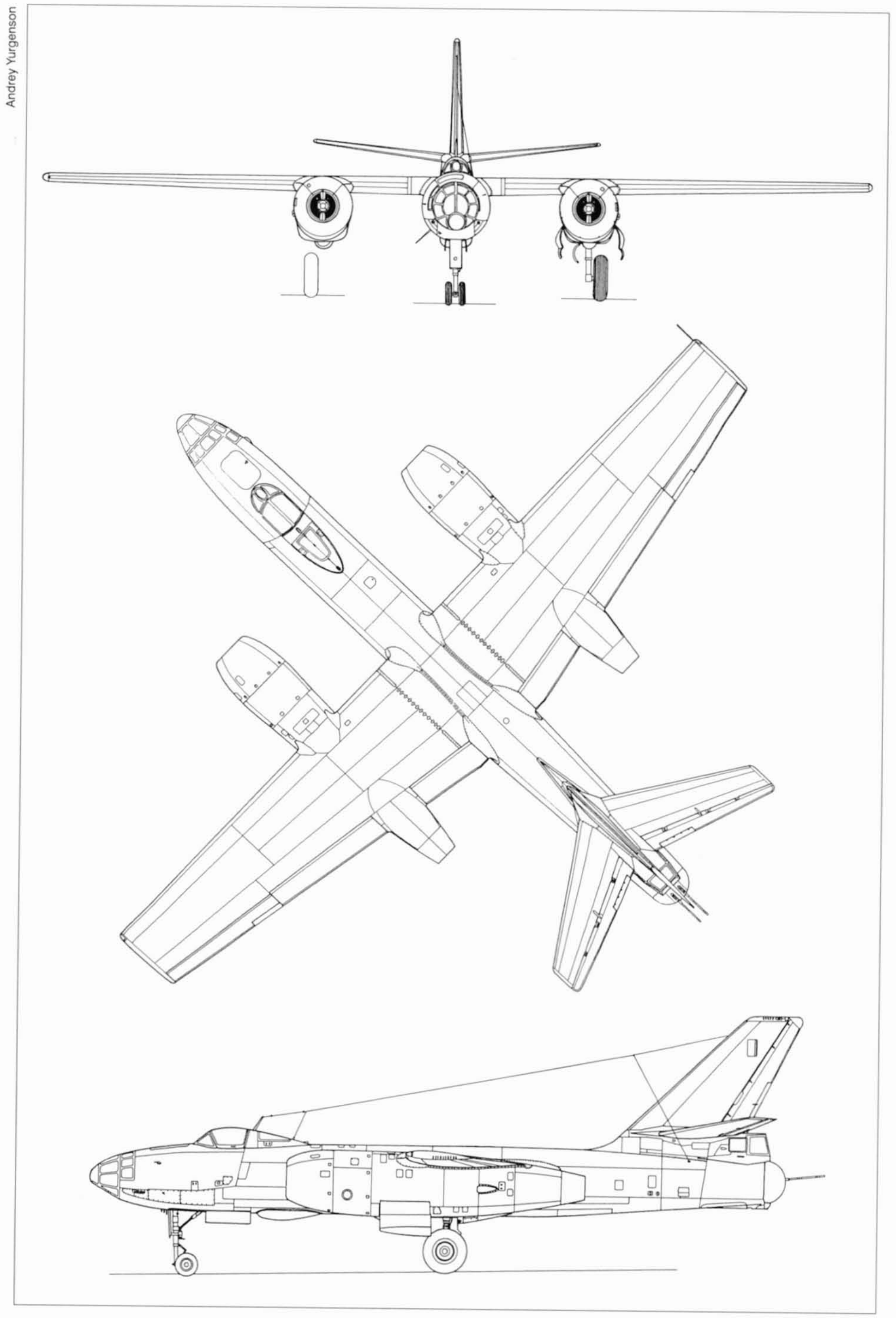
Wings: Cantilever shoulder-mounted two-spar structure built in three sections. The centre section is integrated into the fuselage and the detachable one-piece wing panels carry the engine nacelles. The wings employ a TsAGI SR-5S (P11-1) airfoil with a thickness-to-chord ratio of 12%. Dihedral 1°12', incidence 3°, aspect ratio 7.55, taper 2.08.

The wing box formed by two spars (attached to the fuselage at frames Nos 23 and 27), reinforced skins and multiple ribs and stringers accepts the aerodynamic loads. The wing skins are 2-4 mm (0.07-0.15 in) thick. On the outer portions, the trailing edge is occupied by ailerons, the starboard aileron incorporating a trim tab. The rest of the trailing edge is occupied by two-section hydraulically-actuated slotted flaps inboard and outboard of the engine nacelles. The flap settings are 20° for take-off and 48° for landing; total flap area is 7.45 m² (80 sq ft). Both the ailerons and the flaps are horn-balanced to reduce control/actuator forces.

Tail unit: Conventional swept tail surfaces with cantilever tailplanes mounted at the base of the fin. The fin and the stabilisers have a two-spar structure and are attached to the rear fuselage by three pairs of bolts each.

The fin is swept back 41° at quarter-chord (leading-edge sweep is 45°). The stabilisers have 33° leading-edge sweep and 7° dihedral. The one-piece rudder and one-piece elevators are carried on three brackets each. The tail unit utilises symmetrical NACA airfoils with a thickness-to-chord ratio of 12-10% for the vertical tail and 11-10% for the horizontal tail. Stabiliser span is 7.36 m (24 ft 1¾ in), stabiliser area is 10.82 m² (116.34 sq ft); fin area is 7.8 m² (83.87 sq.ft).

Landing gear: Pneumatically retractable tricycle type, with oleo-pneumatic shock absorbers on each unit. The aft-retracting nose unit has twin wheels – originally 600 x 155 mm (23.6 x 6.1 in), later 600 x 180 mm (23.6 x 7.08 in) or 600 x 185 mm (23.6 x 7.28 in). The main units with single 1,150 x 355 mm (45.27 x 13.97 in) wheels retract forward into the lower portions of the engine nacelles, the wheels turning through 90° by means of mechanical linkages to lie flat under the engine jetpipes. The nosewheel well is closed by a forward door segment attached to the nose gear oleo and two lateral doors; each mainwheel well is closed by twin lateral doors and a small rear door hinged on the inboard side. All wheel



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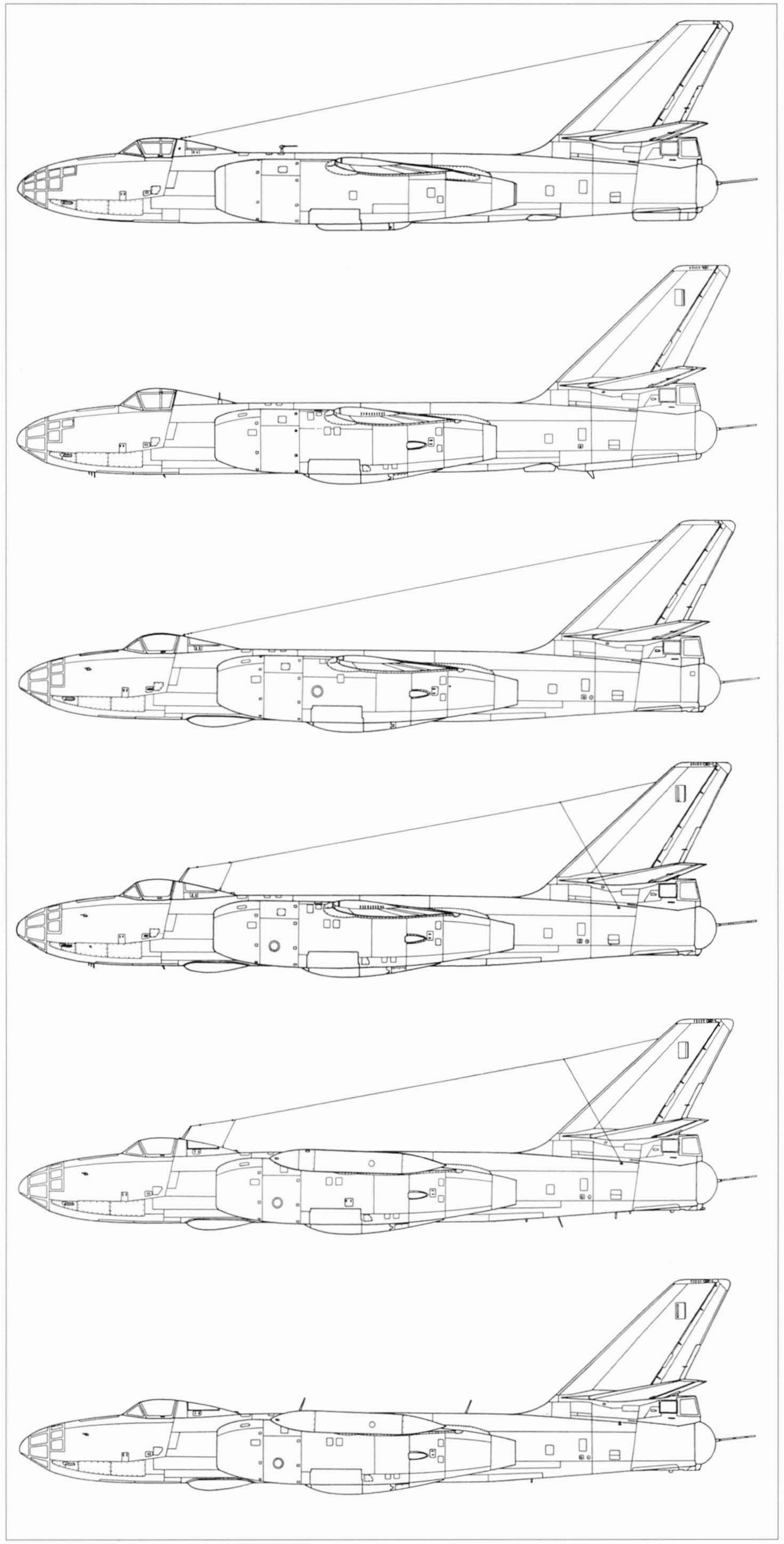
A three-view of a typical production IL-28.



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Top to bottom: the first prototype; the second prototype; an early-production IL-28; a late-production IL-28; an early-production IL-28R an updated IL-28R.

well doors remain open when the gear is down.

The IL-28R features a hydraulically-retractable landing gear 1,260 x 390 mm (49.6 x 15.35 in) mainwheels with a hydraulic spin-up system to prolong tyre life. Wheel track 7.4 m (24 ft 3⅜ in), wheelbase 6.677 m (21 ft 10⅞ in). Nosewheel tyre pressure 4.5 kg/cm² (64.28 psi), mainwheel tyre pressure 7-8 kg/cm² (100-114 psi).

Powerplant: Two Klimov VK-1A centrifugal-flow non-afterburning turbojets, each rated at 2,700 kgp (5,950 lbst) for take-off and 2,400 kgp (5,290 lbst) for cruise. The VK-1A has a single-stage centrifugal compressor, nine straight-flow combustion chambers, a single-stage axial turbine and a subsonic fixed-area nozzle. The engine features an accessory gearbox for driving fuel, oil and hydraulic pumps and electrical equipment. Starting is electrical by means of an ST2 or ST2-48 starter.

The engines are installed in area-ruled underwing nacelles and fitted with long extension jetpipes. Each engine is mounted on a truss-type bearer via four attachment points: two trunnions on the sides of the compressor casing below the axis of the engine and two mounting lugs in the upper part of the engine. The forward part of each nacelle consists of two annular cowling sections, the front section incorporating a parabolic air intake centrebody carried on a straight-through vertical pylon; when these are detached, the engine is exposed almost completely for maintenance or removal.

To reduce the take-off run, two PSR-1500-15 solid-fuel jet-assisted take-off (JATO) boosters with a thrust of 1,650 kgp (3,637 lbst) and a burn time of 13 seconds could be fitted to the centre fuselage sides under the wing roots.

Control system: Manual controls throughout. One-piece ailerons for roll control, one-piece elevators for pitch control and one-piece rudder for directional control; the rudder and elevators are horn-balanced to reduce control forces. The starboard aileron, rudder and both elevators incorporate trim tabs. The elevators and rudder have cable control runs, while the ailerons are controlled by push-pull rods. The elevator trim tabs are mechanically operated by means of cables, while the starboard aileron and rudder trim tabs are electrically actuated.

Fuel system: Five self-sealing fuel cells (bladder tanks) located in the fuselage ahead and aft of the wings (No.1, frames 11A through 15; No.2, frames 15 through 18; No.3, frames 18 through 21; No.4, frames 29 through 32; No.5, frames 32 through 36). The cell walls are 3.3-10.8 mm (0.12-0.42 in) thick. The total capacity of the fuel system is 7,908 litres (1,739 Imp gal) on the standard bomber and 6,600 litres (1,452 Imp gal) on the IL-28U trainer. The IL-28R reconnaissance version features modified internal tankage and 950-litre (209 Imp gal) drop tanks at the wingtips, which gives a total of 9,550 litres (2,101 Imp gal).

Electrical system: Two GSR-9000 (later STG-12000) starter-generators driven by the engines and two 12-A-30 lead-acid batteries installed in the fuselage.

Hydraulic system: The hydraulic system operates the flaps, wheel brakes and, on the IL-28R, the landing gear actuators and mainwheel spin-up drives. Hydraulic power is provided by a GNP-1 hydraulic pump driven by the port engine, with two hydraulic accumulators as a backup.

Pneumatic system: The hydraulic system operates the landing gear (on all versions except the IL-28R), bomb bay doors, gunner's station entry hatch, and inflatable canopy/hatch seals. In an emergency it is also used to deploy the flaps, operate the wheel brakes and jettison the navigator's hatch cover. Compressed air is stored in several spherical bottles which are charged on the ground and topped up by engine bleed air in flight.

De-icing system: The wings, tail unit and engine air intakes are de-iced by engine bleed air.

Armament: The defensive armament comprises four 23-mm (.90 calibre) Nudelman/Rikhter NR-23 cannon. Two of them with 100 rpg are rigidly mounted in the nose, the other two with 225 rpg are carried in the IL-K6 tail turret installed in the rear fuselage and controlled by the gunner.

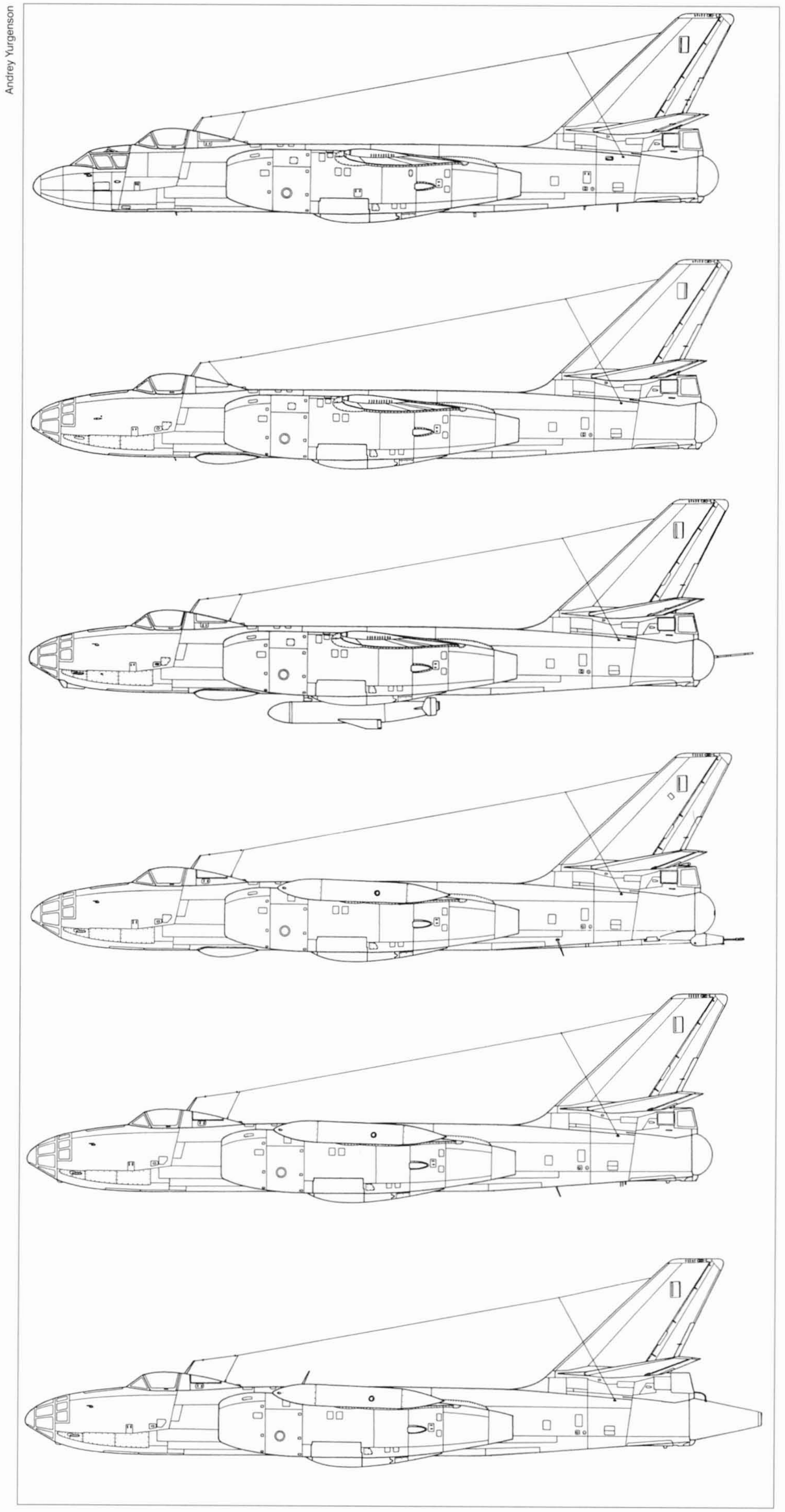
The normal bomb load of the IL-28 is 1,000 kg (2,205 lb) of bombs carried internally, the maximum bomb load is 3,000 kg (6,610 lb) – that is, one FAB-3000 HE bomb.

Avionics and equipment: the IL-28 features a comprehensive avionics suite enabling the aircraft to operate at night and in any weather.

Piloting and navigation equipment: SD-1 VOR receiver, AP-5 electric autopilot, OSP-48 instrument landing system (comprising an ARK-5 Amur automatic direction finder (in a dielectric fairing immediately aft of the cockpit), an RV-2 Kristall low-altitude radio altimeter and an MRP-48 Dyatel marker beacon receiver), RV-10 high-altitude radio altimeter

Communications equipment: RSU-5 (on early production aircraft) or RSIU-3 Klyon (Maple) UHF command radio; RSB-5 communications radio with antenna cable stretched between fin top and antenna mast immediately aft of the cockpit; SPU-5 intercom.

Flight instrumentation: AGK-47B artificial horizon, GPK-46 gyro compass, DGMK-3



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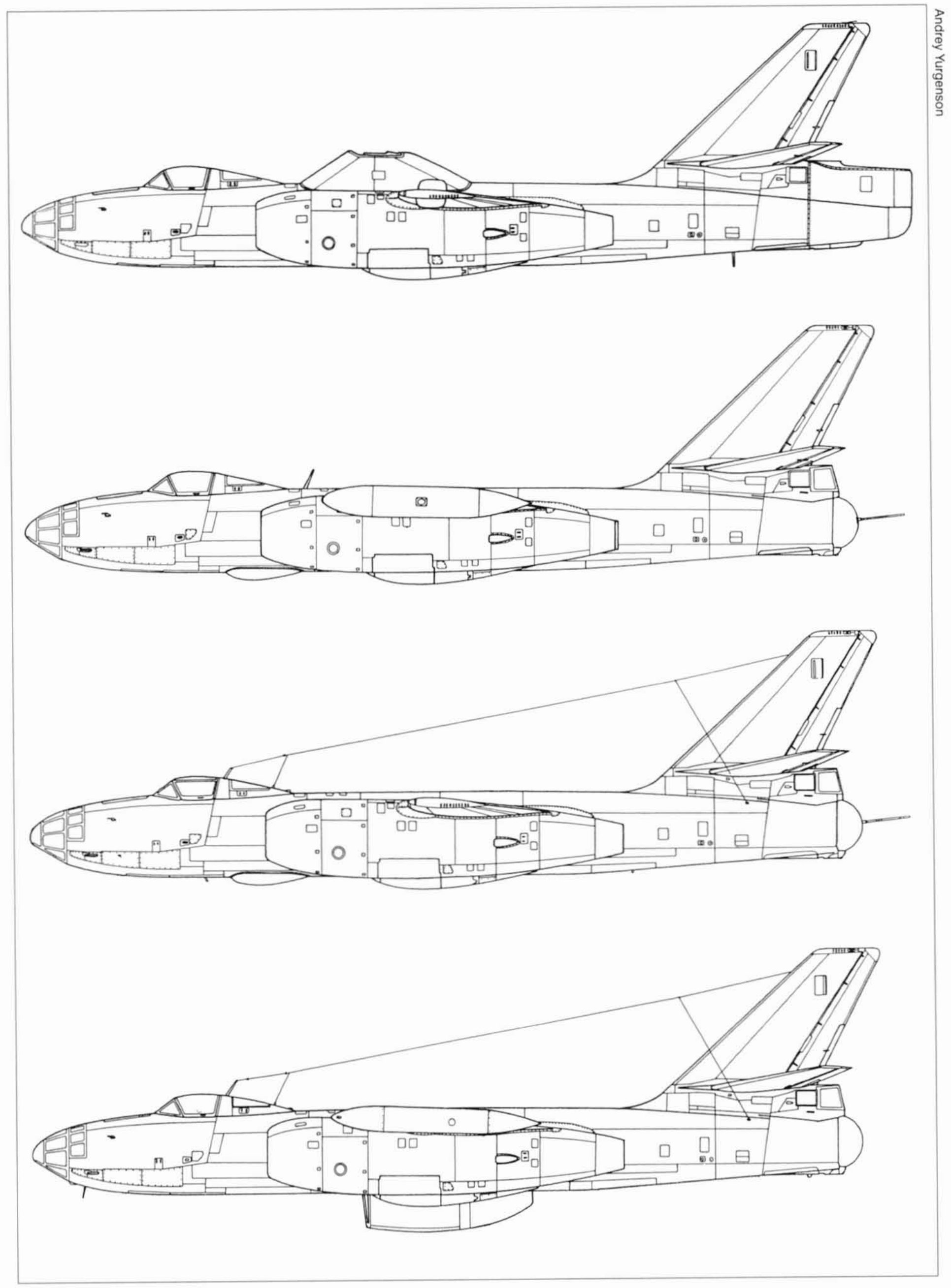
Top to bottom: a production IL-28U; the IL-28P (IL-20); the IL-28-131; an IL-28BM based on the IL-28R; an East German Air Force IL-28R/target tug conversion; the IL-28LL testbed for a Dooshkin rocket motor.



Top to bottom: the IL-28LL ejection seat testbed ('10 Blue', c/n 53005710); the IL-28RM; the IL-28 2VK-5E prototype and the East German IL-28R engine testbed with the Pirna 014 turbojet.

remote gyromagnetic compass indicator, KI-11 compass, AB-52 navigation display, KUS-1200 airspeed indicator (ASI, kombineerovannyy ookazahtel' skorosti), VD-17 altimeter, RV-2 radio altimeter indicator, EUP-46 electric turn and bank indicator (elektricheskiy ookazahtel' povorota), VAR-75 vertical speed indicator (VSI, variometr), UP-2 turn indicator (ookazahtel' povorota), MA-095 Mach meter, AVR-M and AChKhO chronometers etc.

Targeting equipment: PSBN-M 360° ground-mapping and search radar under the forward fuselage, OPB-6SR optical computing bomb sight (on radar-equipped aircraft only; substituted by the OPB-5S on aircraft with the radar removed), PKI collimator gunsight (for the pilot) and a collimator gunsight for the gunner. The revolving radar antenna is covered by a teardrop fairing made of PVC.

IFF equipment: Bariy-M (Barium) IFF transponder in rear fuselage, later replaced by SRO-2M Khrom (Chromium) IFF transponder (*samo**lyot**nyy **rah**diolokatsi**on**nyy o**tvet**chik*) with triple rod aerials ahead of the nose gear unit.

Rescue equipment: In an emergency, the pilot and navigator/bomb-aimer use upward-firing ejection seats. The tail gunner/radio operator bails out downwards via the entrance hatch; the hatch cover is actuated by twin pneumatic rams, doubling as a slipstream deflector.

Specifications

Length overall	17.65 m (57 ft 10⅞ in)
Wing span	21.45 m (70 ft 4½ in)
Height on ground	6.7 m (21 ft 11¾ in)
Wing area, m^2 (sq ft)	60.8 (653.76)
Empty operating weight, kg (lb)	12,890 (28,420)
Gross weight, kg (lb):	
normal	18,400 (40,560)
maximum	21,000 (46,300)
in overload condition	23,200 kg (51,150)
Maximum landing weight, kg (lb)	14,750 (32,520)
Bomb load, kg (lb):	
normal	1,000 (2,205)
maximum	3,000 (6,610)
Top speed, km/h (mph):	
at sea level	800 (496)
at 4,500 m (14,760 ft)	902 (560)
at 10,000 m (32,810 ft)	855 (531)
Unstick speed, km/h (mph):	
with a 18,400-kg (40,560-lb) TOW	235 (146)
with a 23,200-kg (51,150-lb) TOW	260 (161)
Landing speed, km/h (mph)	185 (115)
Rate of climb, m/sec (ft/min)	15 (2,950)
Service ceiling, m (ft):	
with a 18,400-kg TOW	12,500 (41,010)
with a 23,200-kg TOW	10,750 (35,270)
Time to height, minutes*:	
to 5,000 m (16,404 ft)	6.5
to 10,000 m (32,808 ft)	18.0
to 12,500 m (41,010 ft)	31.0
Time to service ceiling, minutes:	
with a 18,400-kg TOW	40.7
with a 23,200-kg TOW	45.4
Range, km (miles) †	1,930 (1,198)
Endurance †	3 hrs 07 min
Take-off run, m (ft)*:	
concrete strip, unstick speed 220 km/h (136 mph)	875 (2,870)
dirt strip, unstick speed 235 km/h (146 mph)	1,290 (4,230)
Take-off run, m (ft) ‡:	
concrete strip, unstick speed 260 km/h (161 mph)	1,720 (5,640)
dirt strip, unstick speed 260 km/h (161 mph)	2,350 m (7,710)
Landing run, m (ft)	1,170 (3,840)

* With a 18,400-kg (40,560-lb) TOW
† With a 20,750-kg (45,745-lb) TOW and cruising at 9,700-11,500 m (31,820-37,730 ft)
‡ With a 23,200-kg (51,150-lb) TOW

IL-28T torpedo-bombers carried an LAS-3 inflatable rescue dinghy; it was also carried by reconnaissance aircraft and bombers on overwater missions.

Exterior lighting: Port (red), starboard (green) and tail (white) navigation lights; retractable landing lights in the outer faces of the engine nacelles.

IL-30 tactical bomber

This ill-fated aircraft, destined never to leave the ground, had its inception at the time when construction of the IL-28 prototype was not yet completed. The work on the project of a new tactical bomber, designated IL-30, started on 21st June 1948. This machine, to be powered by two TR-3 turbojets designed by Arkhip M. Lyul'ka, was intended to meet the following specifications: normal bomb load 2,000 kg (4,410 lb); range 3,500 km (2,175 miles); maximum speed not less than 1,000 km/h (621 mph).

As distinct from the IL-28, whose VK-1 engines had centrifugal compressors, the new bomber was to be powered by engines with axial compressors which could be housed in slimmer nacelles.

In early March 1949 the full-scale mock-up of the IL-30 was inspected by the Air Force's mock-up review commission which came to favourable conclusions. Interestingly, construction of the prototype had already begun and the bomber had reached 85% completeness by that time.

The new aircraft, while possessing basically similar dimensions to the IL-28, differed from it in several important respects. The most important difference was the use of swept wings which were considered essential in order to meet the specified speed target of 1000 km/h. A sweepback angle of 35° at quarter-chord was chosen (a feature common to many Soviet jet aircraft designs of that period); the wings had a 12% thickness/chord ratio. The swept wings did have beneficial effects on the aircraft's aerodynamics at high subsonic speeds, enabling it to reach higher performance; yet, they also possessed certain drawbacks as compared to straight wings. In particular, the swept wings possessed somewhat inferior lifting properties; attempts to make up for that by increasing the angle of attack caused an earlier onset of tip stall as compared to straight wings. A remedy was found, firstly, in reducing the wing taper and, secondly, in fitting boundary layer fences to the wings' upper surfaces to limit the spanwise flow. As many as four fences were mounted on each wing, two of them outboard and two inboard of the engine nacelles.

The rather moderate 12% thickness/chord ratio dictated by the decreased taper created some problems associated with obtaining the required stiffness and strength of the wing/fuselage joints. It also reduced the volume of fuel tankage that might be housed in the wings; in consequence, the specified maximum range could be obtained only through the use of drop tanks mounted at the wingtips.

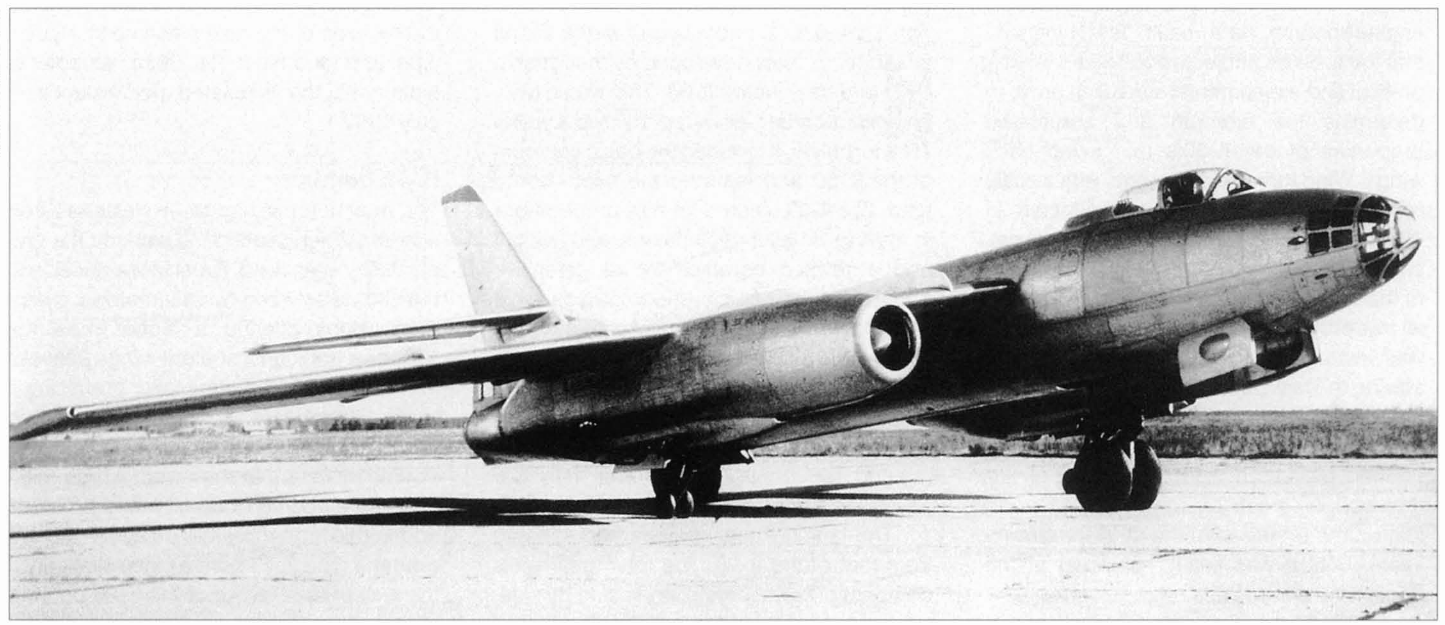
When choosing the location for the engines on the aircraft, Ilyushin studied several configurations, eventually settling for the same arrangement as on the IL-28. The engines were to be housed in slim nacelles attached directly to the underside of the wings. The engine nacelles, like those of the IL-28, were 'area-ruled', their waist being narrowest where the wing airfoil was at its thickest.

The wing sweepback entailed some superfluous lateral stability; to counteract it, the wing was given a slight anhedral of 2°. As distinct from the IL-28 with its shoulder-mounted wings, the IL-30 featured mid-set wings. This, coupled with the wing anhedral, reduced the clearance between the ground and the underwing-mounted engine nacelles, making it difficult to use the same arrangement for the stowage of the main gear units as on the IL-28. Instead, the designers had to stow the mainwheels in the fuselage in two units widely spaced fore and aft; thus, the IL-30 became the first Soviet aircraft of considerable size to incorporate a bicycle undercarriage. The choice of this undercarriage layout made it possible to install large-size wheels on the two main units which enhanced the aircraft's ability to operate from unprepared airstrips. At the same time it created some problems with providing adequate fuselage strength and rigidity. The main undercarriage units were supplemented by lightweight twin-wheel outriggers for lateral stability on the ground; these were housed in small fairings under the engine nacelles.

Provision was made for jet-assisted take-off when operating the IL-30 from tactical airstrips. PSR solid-fuel rocket boosters could be attached to the sides of the fuselage; they delivered a thrust of 2,100 kg (4,630 lb) each with a 15-second burn time.

The crew of the IL-30 comprised four persons: a pilot, a navigator/bomb-aimer and two gunners. Three crew members – the pilot, the navigator and a gunner – were accommodated in the forward pressurised compartment; it was subdivided into the pilot's cockpit enclosed by a blown canopy and the navigator's station in the extensively glazed extreme nose reminiscent of the IL-28. They were connected by a passage. The gunner, facing aft, was placed back-to-back with the pilot; his cockpit was also connected with that of the pilot. The fourth crew member – the second gunner manning a tail turret – occupied a pressurised compartment in the rear fuselage.

The aircraft featured a more potent complement of defensive armament compared



Ilyushin's ill-starred IL-30 bore a striking resemblance to the French Sud-Ouest SO 4050 Vautour. Note the extreme nose-up attitude on the ground and the twin-wheel outrigger units under the engine nacelles.

to the IL-28. It comprised six 23-mm (.90 calibre) Nudelman/Rikhter NR-23 cannon. Of these, two were forward-firing fixed cannon mounted in the forward fuselage and fired by the pilot. Defence of the rear hemisphere was provided by two twin-cannon turrets. One of them was the IL-V-12 dorsal barbette installed immediately aft of the cockpit and remotely-controlled by the dorsal gunner. The other one – the IL-K6 turret – was mounted in the extreme tail. The offensive warload comprised bombs to a maximum weight of 4,000 kg (8,820 lb).

The IL-30 prototype was completed in the summer of 1949. At the end of August it was transported from the OKB's experimental shop at Moscow-Khodynka to the flight test facility in Zhukovskiy. Starting in mid-September, the aircraft underwent various checks and development work there. Prior to flight testing, the aircraft made several high-speed runs with the OKB's chief test pilot Vladimir K. Kokkinaki at the controls, the purpose being to check the performance of the unorthodox undercarriage. It turned out that during taxying at slow speeds the aircraft tended to veer off the straight course; as the speed increased, the aircraft became more stable in its movement along the runway.

The first flight of the IL-30 was imminent, yet it was not destined to take place. Doubts arose as to the strength and aerodynamic properties of the bomber's swept wings. A contributory factor to these doubts was an incident which had happened with the Tu-82 experimental tactical bomber, also featuring swept wings. When performing a training flight at low altitude, this aircraft happened to pass through a zone of strong upward air currents of varying intensity; their action caused a failure of one of the aircraft's engine mounts. As a result, TsAGI insisted that the IL-30 be subjected to additional theoretical and experimental studies in order to determine the strength and aeroelastic properties of the IL-30's thin swept-back wings. Wind tunnel experiments with a scale model of the aircraft were conducted in 1950; these experiments, as well as new calculations, demonstrated sufficient strength of the wings. However, the delay caused by all this proved fatal for the aircraft. The OKB was instructed to turn all its resources to solving the tasks associated with the service introduction of the IL-28 and development of its versions. On 20th August 1950 the government issued an order terminating all further work on the IL-30. The prototype stood idle on the premises of the OKB for several years, until it was finally scrapped at the beginning of the 1960s.

Interestingly, when the existence of this aircraft became known in the West, press reports about it contained much guesswork and erroneous information. For example, it was asserted that the IL-30 had a ventral gun barbette; it was also believed that the aircraft had been test-flown and *'became the first Soviet bomber to attain the then magical figure of 1,000 km/h (621 mph)'*.

Specifications of the IL-30 bomber (manufacturer's estimates)

Year	1949
Crew	4
Wing span	16,5 m (54 ft 4 in)
Length overall	18,0 m (59 ft 0⅝ in)
Wing area, m^2 (sq ft)	100 (1,076)
Engine type	TR-3
Engine thrust, kgp (lbst)	2 x 4,600 (10,143)
Weights, kg (lb):	
AUW, normal	32,552
AUW, maximum	37,552
empty weight	22,967
Maximum speed, km/h (mph):	
at sea level	900 (559)
at 5,000 m (16,400 ft)	1,000 (621) *
Cruising speed, km/h (mph)	850 (528)
Time to 5,000 m (16,400 ft), minutes	4
Service ceiling, m (ft)	13,000 (42,650)
Range at 850 km/h (528 mph)	
with a 2,000-kg (4,410-lb)	
bomb load, km (miles)	3,500 (2,175) (with drop tanks)
Bomb load, kg (lb):	
normal	2,000 (4,410)
maximum	4,000 (8,820)
Defensive armament	6 x 23-mm NR-23

* 1,050 km/h (653 mph), according to another source

IL-38 tactical bomber (project) (first use of designation)

The ill-fated IL-30 had a sequel in the shape of another project developed by the Ilyushin OKB and designated IL-38. This was a twin-engined bomber powered by two Lyul'ka TR-3 turbojets. It retained the basic contours of the IL-30 and featured the same bomb load. The IL-38 differed from its predecessor in having smaller dimensions and weight and a revised complement of defensive armament; the bicycle undercarriage gave place to normal tricycle landing gear.

The IL-38 reverted to a crew of three (as on the IL-28); the defensive armament was also borrowed from the *Beagle*, comprising two forward-firing NR-23 cannon supplemented by the IL-K6 tail turret with two NR-23s to protect the rear hemisphere.

The landing gear arrangement differed from that of the IL-28. The main gear units comprised four separate struts side by side, two under each engine nacelle. Each strut carried a single wheel (inboard of the oleo on the inner units and outboard on the outer ones); in extended position the wheel axles were aligned. One of the struts of each unit retracted forwards and the other aft, the wheels swivelling through 90° to lie flat in the bottom of the engine nacelle. This arrangement resulted in the characteristically low sit of the aircraft on the ground.

The project drew favourable comment from the Air Force. However, the military wished to see the field performance improved through the use of more powerful engines.

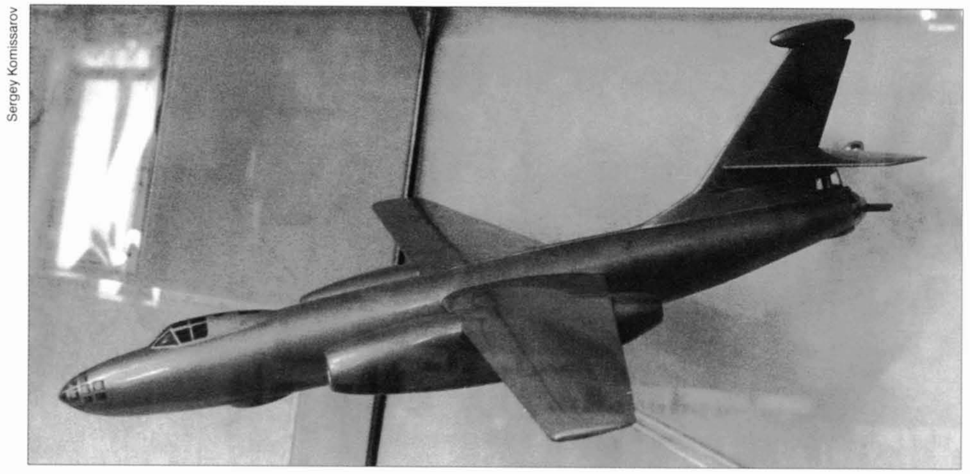
IL-42 tactical bomber (project)

In compliance with these wishes and pursuant to the government directive dated 10th July 1950, the IL-38 project was reworked by the OKB to accept the TR-3A (AL-5) engines with a take-off thrust of 5,000 kgp (11,025 lbst). The new aircraft was designated IL-42 (this designation was re-used later for an attack aircraft – see Chapter 1). With a normal bomb load of 2,000 kg (4,410 lb) it was to have a range of 2,400 km (1,490 miles) – same as the IL-28; its field performance should make it suitable for the same airfields as the IL-28. The directive stipulated that the aircraft be submitted for State Acceptance trials in December 1951. The OKB set about issuing detail drawings and making preparations for the construction of the prototype. More than 50% of the manufacturing drawings had been issued and the construction of the prototype had actually started when the customer came up with a new, radically revised specification. It called for increasing the range twofold and the maximum bomb load 1.5 times, as against the previous figure of 4,000 kg (8,820 lb). The new requirements were set forth in a government directive dated 24th March 1951. It required the OKB to start manufacturer's tests of the new machine in a year's time and submit it for State acceptance trials, with the stipulated performance, in July 1952.

IL-46 bomber

The new bomber had to be designed from scratch. When starting the work on the project designated IL-46, Ilyushin was faced with the choice between two alternatives: swept-back wings offering a higher maximum speed vs traditional straight wings possessing better lift properties and promising a longer range. He opted for the straight wings, guided, among other things, by apprehensions that the swept wings might become a source of unexpected problems and cause impermissible delays in the programme. The IL-46 bore a close similarity to the well-proven layout of the IL-28 bomber; in fact, it resembled a scaled-up IL-28, but was much larger and heavier. However, being conscious of the inherent advantages of swept wings for high-speed aircraft, Ilyushin decided to start work in parallel on a project featuring swept wings. It was designated IL-46S (*strelo**vid**noye* [*kry**lo***] – swept wings). The work on the two designs proceeded concurrently; the straight-wing version was expected to attain a maximum speed of 900-925 km/h (559-575 mph), while the swept-wing version was considered capable of reaching 1,000 km/h (621 mph).

Another major problem affecting the layout of the new bomber was the choice of the optimum defensive armament complement. The customer (the Air Force command) was of the opinion that the arrangement used previously on the IL-28 and featuring only a pair of forward-firing fixed guns and a tail turret was inadequate in this case; Air Force specialists wanted the new bomber to be given all-round protection in the front and rear hemispheres. Ilyushin contested these views, pointing out that an attempt to put this approach into practice would result in an unjustifiable increase in the weight and dimensions of the aircraft. In the end, Ilyushin's point of view prevailed and the IL-46 did, in fact, feature a weapon arrangement similar to that of the IL-28. This determined the crew complement which comprised a pilot, a navigator/bomb-aimer and a tail gunner. Interestingly, Ilyushin's competitor – OKB-156 headed by Andrey N. Tupolev – chose a different approach and provided its rival bomber design, the '88' (later known as the Tu-16) with an impressive array of three turrets in addition to a forward-firing fixed cannon. Accordingly, the crew comprised six or seven persons.

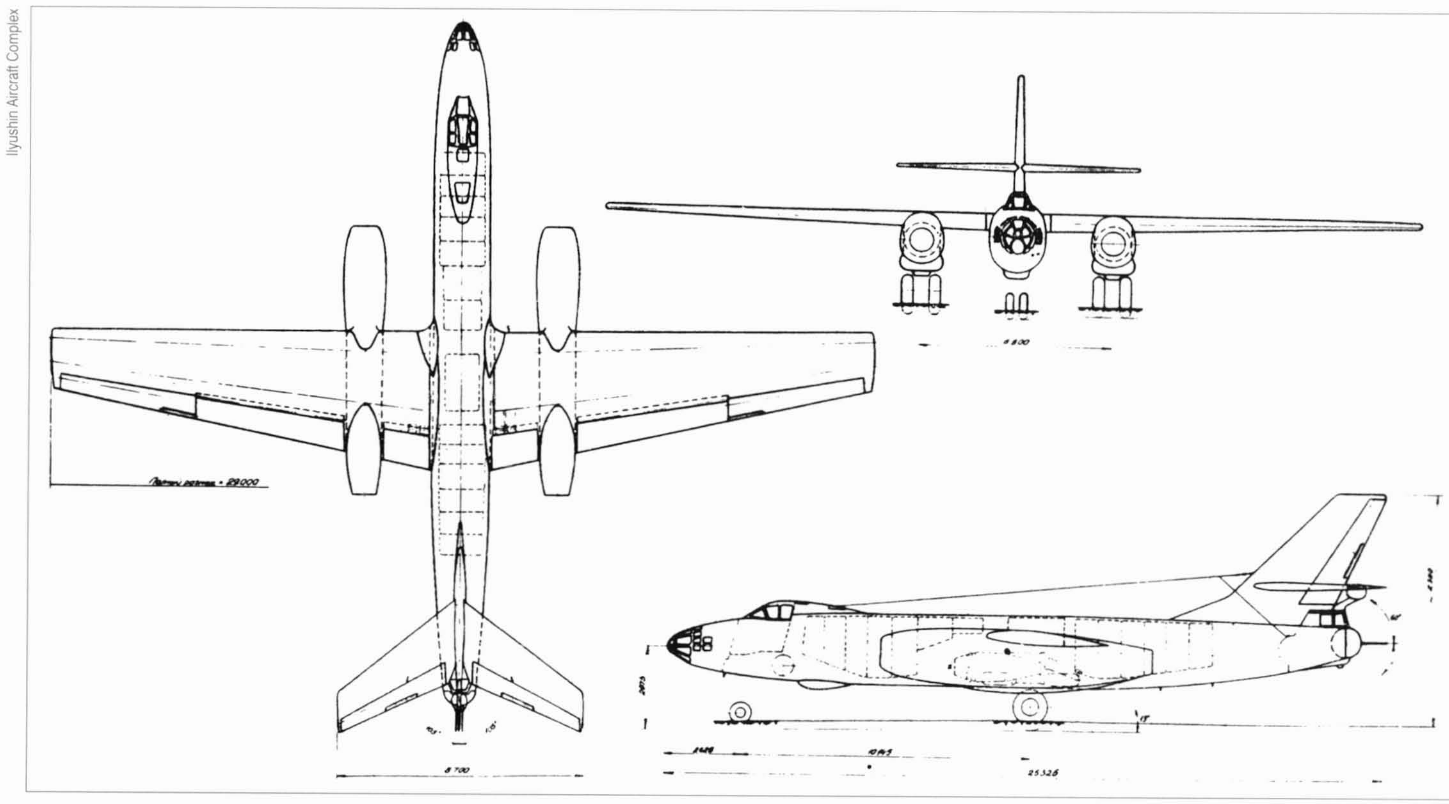


Sergey Komissarov

Above: This model of the IL-46 displayed at the Central Armed Forces Museum in Moscow features a cigar-shaped fairing at the top of the fin and a PRS-1 gun ranging radar above the tail gunner's station. None of them were fitted to the actual aircraft.

As mentioned above, it was the straight-wing version of the IL-46 that was chosen for the construction of the prototype which was completed in January 1952. The aircraft was powered by two Lyul'ka AL-5 (TR-3A) axial-flow turbojets rated at 5,000 kgp (11,025 lbst) for take-off. The engines were housed in long slim nacelles protruding far ahead of the wing; they occupied the front part of the nacelles and had to be fitted with very long jet exhaust pipes. The nacelles also provided place for the stowage of the main undercarriage units when retracted. Their design was similar to that used on the IL-38. Each main unit consisted of two separate single-wheel struts; during retraction they swivelled in opposite directions, the inboard struts retracting forwards and the outboard struts aft, and the wheels turned through 90° to lie flat in fairings on the underside of the engine nacelle.

Provision was made for the use of solid-fuel JATO boosters for operations from short runways; a PSR-2000-15 jettisonable unit developing 2,000 kgp (4,410 lbst) of thrust with a 15-second burn time could be fitted to each side of the aft fuselage for this purpose.



Ilyushin Aircraft Complex

A three-view of the IL-46 from the project documents.

Ilyushin Aircraft Complex

Above: The sole prototype IL-46 during manufacturer's flight tests; the aircraft's IL-28 lineage is patently obvious. Note the unusual side-by-side pairs of main gear struts retracting in the opposite directions and the side-by-side placement of the fixed forward-firing cannon on the port side of the nose.

The IL-46 featured reversible hydraulic actuators in the elevator, rudder and aileron control circuits, which was a novel feature at the time; they made the bomber much easier to fly.

The defensive armament comprised four 23-mm Nudelman/Rikhter NR-23 cannon. Two of them were fixed forward-firing cannon placed side-by-side on the port side of forward fuselage close to the navigator's cockpit. Placed in the extreme aft fuselage was the IL-K8 electrohydraulically actuated remote-controlled tail turret with two NR-23 cannon. The field of fire was 105° to either side, 58° upwards and 39° downwards. The ±105° traversing angle was considerably greater than that of the IL-K6 turret installed in the IL-28. Ilyushin was of the opinion that this feature would enable the tail gunner of the IL-46 to engage enemy fighters flying on a parallel course and would obviate the need for a dorsal turret. The gunner was to be provided with the PRS-1 Argon gun-laying radar (PRS = *pri**tsel** **rah**diolokatsi**on**nyy strel**kov**yy* – 'gunner's radar sight') which would enable him to repel fighter attacks at night and in adverse weather. As can be seen on a model, this radar was to be housed in an egg-shaped fairing mounted on an outrigger above the gunner's station. However, development of this radar suffered delays; it was not available on time and hence was not installed on the prototype.

The offensive armament in normal configuration amounted to 3,000kg (6,610 lb) of bombs carried in the bomb bay; in overload configuration the bomb load was increased to 6,000 kg (13,230 lb), also stowed internally.

Between 29th and 30th December 1951 the IL-46 prototype was transported from Moscow to the OKB's test facility in Zhukovskiy where further work was done on the machine prior to the beginning of the flight tests.

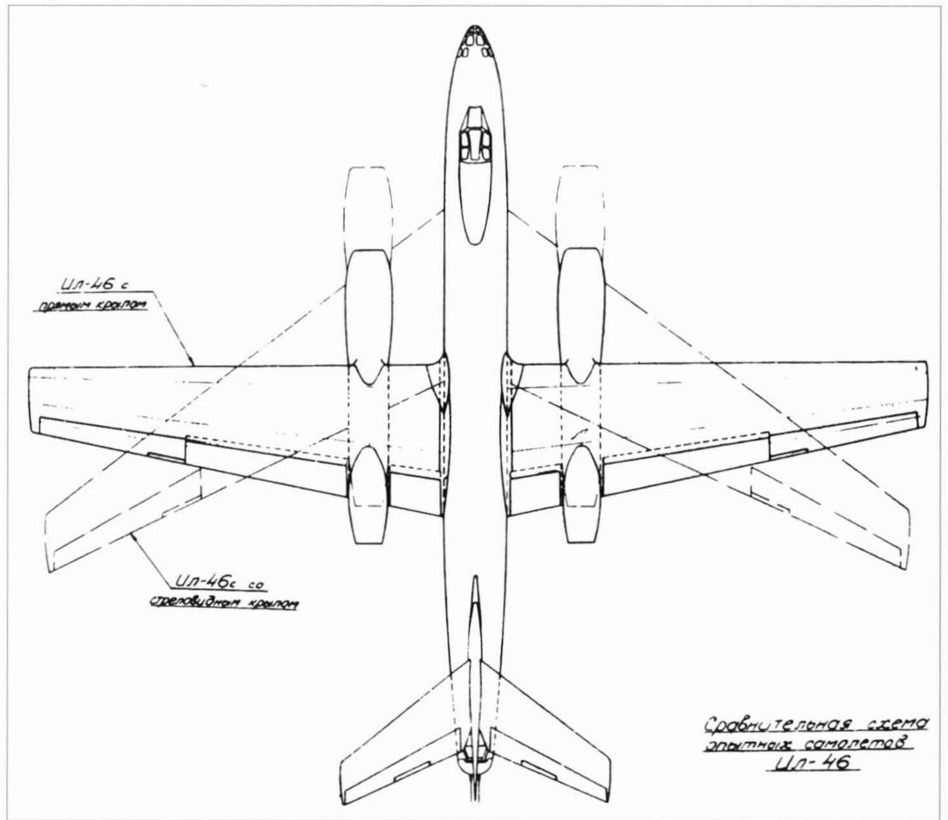
The IL-46 made its maiden flight with Vladimir K. Kokkinaki at the controls on 3rd March 1952. The test pilot's first impressions were quite favourable. The aircraft displayed no vices, it behaved normally in all flight modes and had good stability and controllability, being capable of executing all the requisite manoeuvres.

Manufacturer's tests of the IL-46 were conducted at the normal all-up weight of 42,000kg (92,610 lb) with a 3,000-kg bomb load and at the overload AUW of 52,800 kg (116,420 lb) with a 6,000-kg bomb load. The bomber attained a maximum speed of 928 km/h (577 mph) and a range of 4,845 km (3,011 miles) with a bomb load of 5,000 kg (11,025 lb) which was dropped at mid-range. Before the manufacturer's tests were completed on 31st July 1952, the aircraft had made 53 flights, logging 92 hours.

State Acceptance trials of the IL-46 were conducted in the period between 15th August and 15th October 1952. The aircraft passed these trials successfully, the bomber's performance meeting the specifications approved by the Government.

Upon completion of the State Acceptance tests the IL-46 prototype was re-engined with improved AL-5F afterburning turbojets providing 5,750 kgp (12,680 lbst) of thrust for take-off in full afterburner. The greater thrust resulted in improved performance of the IL-46. However, despite this fact and despite the positive results of the State acceptance trials, the IL-46 was not adopted for series production and service. It lost to its rival – Andrey N. Tupolev's prototype '88' bomber, the future Tu-16, which was submitted for State acceptance trials at that time. Ironically, this was a reversal of the situation with the IL-28 and the Tu-14 in which the Tupolev bomber had lost to Ilyushin's bomber. In this case, the military opted for the Tu-88 (Tu-16) although it had not yet passed its State Acceptance trials. The decisive factors were the Tupolev machine's swept-back wings enabling the bomber to attain a maximum speed of 1,000 km/h (621 mph) and its more powerful defensive armament (Ilyushin had obviously failed, after all, to convince the military of the soundness of his concept as regards the armament).

As a result, the Government ordered all work on the IL-46 to be terminated. This also put an end to the construction of the second IL-46 prototype, the IL-46S featuring swept wings, which is described below.



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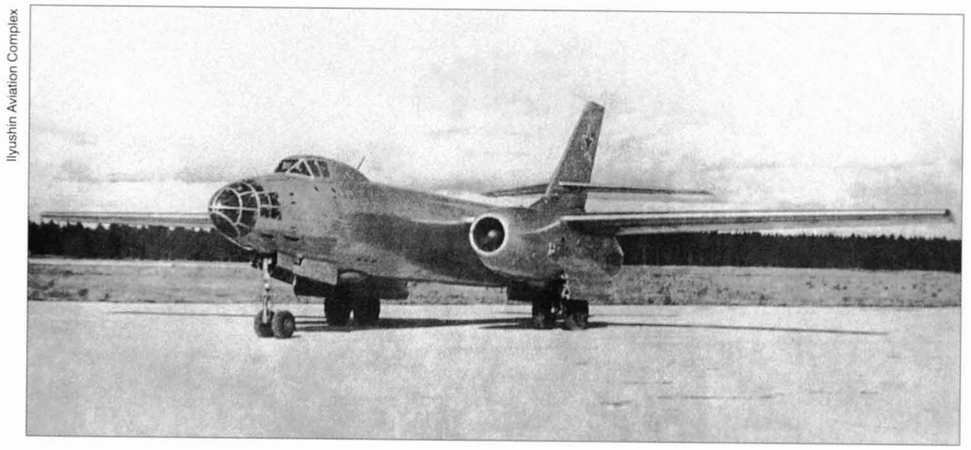
This drawing gives a comparison of the IL-46 (solid lines) and the IL-46S. Note how much further forward the latter's wings are (albeit the landing gear wheelbase remains unchanged).

IL-46S swept-wing bomber (project)

As stated above, concurrently with the construction and testing of the straight-wing IL-46 prototype, the OKB conducted design work on the swept-wing version, the IL-46S. The advanced development project of this version was endorsed by Ilyushin in early December 1951. The wing area was slightly increased to compensate for the inferior lifting properties of the sweptback wings. Thicker wing roots designed to ensure adequate wing stiffness housed additional fuel tankage. The wing/fuselage joint was moved forwards; this led to some changes in the fuselage structure, making it possible to increase the length of the bomb bay to 7.8 m (25 ft 7 in). Another consequence was the more forward position of the engine nacelles; to retain the same position of the main undercarriage units relative to the fuselage, the engine nacelles had to be extended aft. As shown on a model displayed at the Central Armed Forces Museum in Moscow, the aircraft featured a cigar-shaped fairing at the top of the fin; it presumably housed communications equipment and a radar warning receiver. Interestingly, this fairing can also be seen on a model of the straight-wing IL-46, although it was absent on the prototype.



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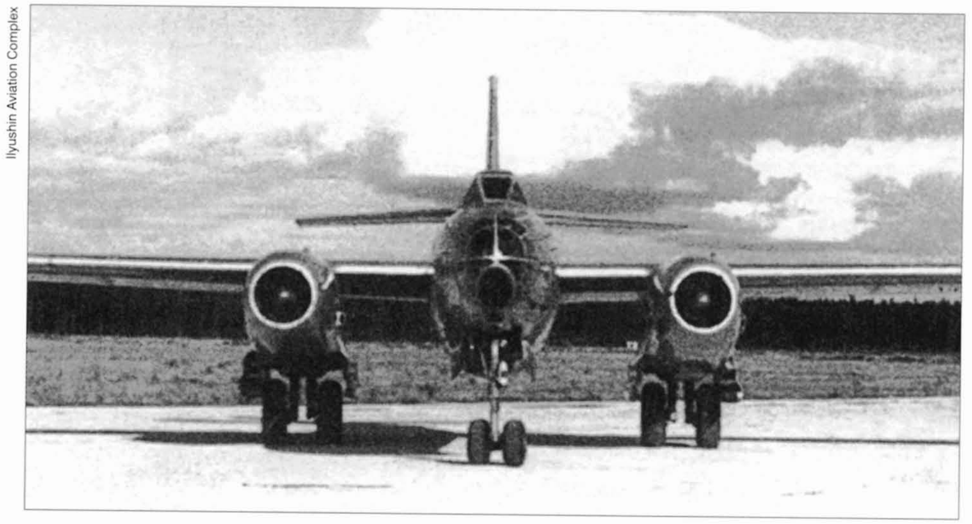

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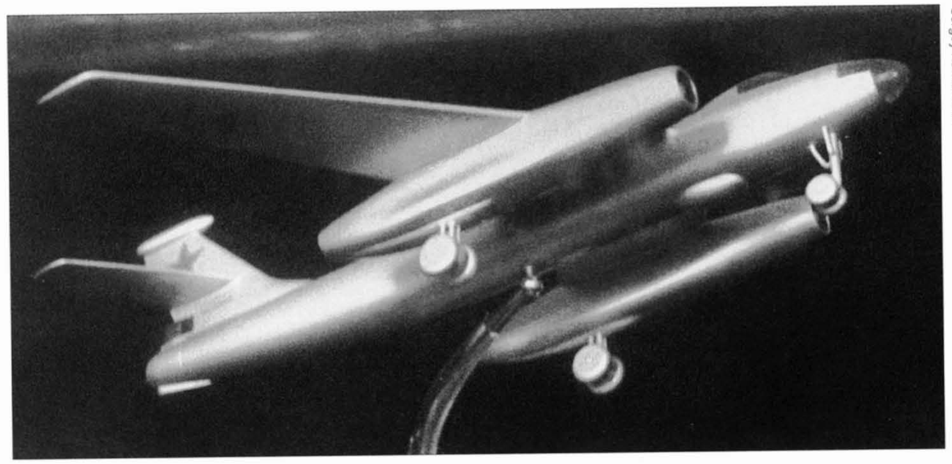
Four shots of the IL-46 prototype during State acceptance trials.



Sergey Komissarov

Above: This model of the IL-46S displayed at the Central Armed Forces Museum in Moscow shows the aft position of the twin main gear units with respect to the engine nacelles.

Yefim Gordon archive

An artist's impression of the IL-46S. Note that the main landing gear units are depicted incorrectly.

Specifications of the IL-46 and IL-46S (design performance figures for the latter)

Type	IL-46	IL-46S
Year	1952	1952
Crew	3	3
Wing span	29.00 m (95 ft 1 in)	29.00 m (95 ft 1 in)
Length overall	25.325 m (83 ft 1 in)	25.325 m (83 ft 1 in
Wing area, m² (sq ft)	105.0 (1,130.3)	In excess of 105.0 (1,130.3)
Engine type	AL-5	AL-5
Engine thrust, kg (lb)	2 x 5,000 (2 x 11,025)	2 x 5,000 (2 x 11,025)
Weights, kg (lb):		
AUW, normal	41,840 (92,257)	41,840 (92,257)
AUW, maximum	52,425 (115,597)	52,788 (116,389)
empty weight	26,300 (57,991)	26,300 (57,991)
Maximum speed, km/h (mph)	928 (577)	1,000 (621)
Cruising speed, km/h (mph)	n.a.	800 to 830 (497 to 516)
Landing speed, km/h (mph)	202 (126)	202 (126)
Time to 5,000 m (16,400 ft),min	6.8	n.a.
Service ceiling, m (ft)	12,700 (41,670)	12,700 (41,670)
Range with a bomb load of 5,000 kg (11,025 lb), km (miles)	4,845 (3,011) (4,970/3,088)	4,845 (3,011)
Bomb load, kg (lb):		
normal	3,000 (6,615)	3,000 (6,615)
maximum	6,000 (13,230)	6,000 (13,230)
Take-off run, m (ft)	1,335 (4,380)	approx. 1,400 (4,590)
Landing run, m (ft)	670 (2,200)	approx. 700 (2,300)
Defensive armament	4 x NR-23	4 x NR-23

IL-54 transonic bomber prototype

In December 1952 the Ilyushin OKB started its work on a project of a transonic tactical bomber which received the designation IL-54. The official go-ahead for the work was given by a Council of Ministers directive dated 29th December 1952. It contained the following specification for the new aircraft: a maximum speed of Mach 1.15 at an altitude of 4,750 m (15,585 ft); an effective range of 2,200-2,500 km (1,367-1,554 miles) with a normal bomb load of 3,000 kg (6,610 lb). The aircraft was to be submitted for State acceptance trials in July 1954 (this estimate proved to be too optimistic!).

The stipulated transonic maximum speed was the governing factor in choosing the layout of the new bomber. In the opinion of the OKB's aerodynamics experts, attaining this speed dictated the use of thin wings with a very considerable angle of sweepback – 55°. Such wings, while possessing the necessary properties for transonic cruise, were at a disadvantage in comparison with straight or moderately swept wings with regard to range and field performance. Among other things, this entailed an increase of the take-off and landing speeds and of the required runway length.

All these considerations, coupled with due regard to the available engine performance, formed the basis for evolving the aircraft's basic layout. As usual, a number of configurations was studied; one of them (according to a published drawing) was a low-wing monoplane with cruciform tail surfaces and with the engines in small nacelles flanking the fuselage above the trailing edge of the wing roots. However, the first version officially endorsed by Ilyushin on 23rd March 1953 was quite different. It envisaged a three-crew aircraft with mid-set wings, two turbojets flanking the fuselage (with air ducts passing through the wing roots) and a sharply swept T-tail. The crew accommodation and defensive weapons arrangement followed the already well-established pattern first used on the IL-28. The undercarriage was of the traditional tricycle type; the main units retracted forwards into the wing roots, swivelling through 90° and permitting the wheels to lie flat in the wings, as had been the case with the IL-40 attack aircraft.

The aircraft was to have a wing span of 17.65 m (57 ft 11 in ft) and a length of 25.69 m (84 ft 3½ in). Its normal AUW was 36,000 kg (79,380 lb), the empty weight being 22,560 kg (49,745 lb). The powerplant comprised two TRD-1 axial-flow non-afterburning turbojets (later to be known as the Lyul'ka AL-7); in their original version they gave a maximum thrust of 7,700 kgp (16,980 lbst). However, the project documents contain a mention of the engine operating mode 'with thermal (that is, exhaust temperature?) control', probably as a prospective powerplant development. The maximum thrust in this case was 8,600 kgp (18,960 lbst). The design performance included a maximum speed of 1,200 km/h (746 mph) at 5,000 m (16,400 ft) with the engines operating in the normal mode; using 'thermal control' was expected to enable the aircraft to attain 1,255 km/h (780 mph) at the same altitude. An effective range of 2,400 km (1,490 miles) without drop tanks was envisaged; the use of drop tanks would increase the range to 2,750 km (1,709 miles). All these figures look rather too optimistic in comparison with the actual performance of the two prototypes. In addition to the basic bomber version, other versions of this original design were envisaged, including torpedo-bomber, trainer and PHOTINT aircraft.

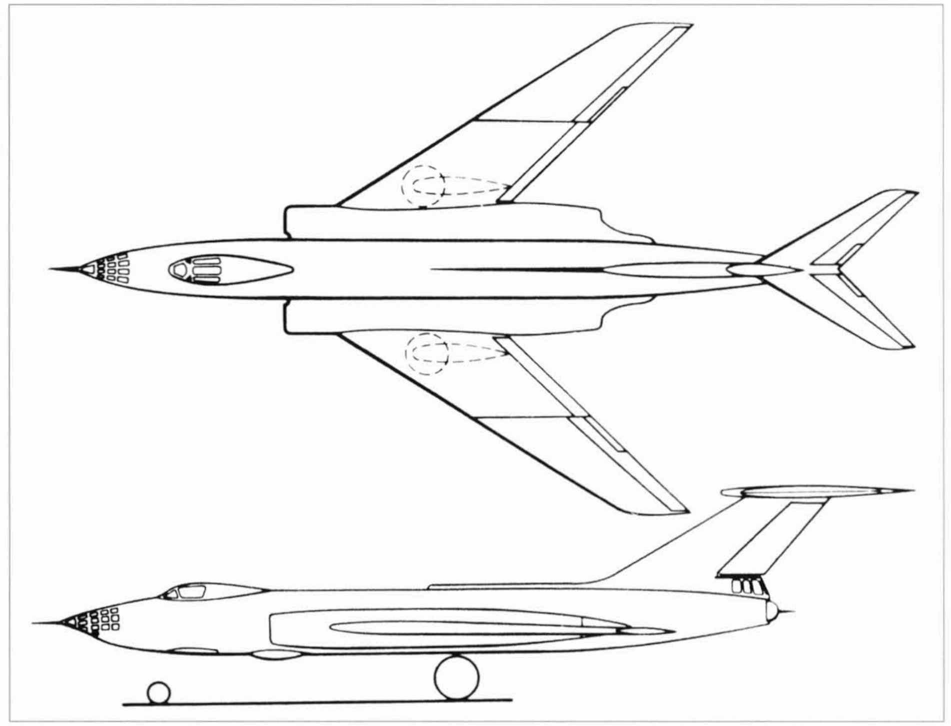
When the military had studied the advanced development project (endorsed by Sergey V. Ilyushin on 7th April 1953) and inspected the full-scale mock-up of the aircraft they voiced criticism concerning the undercarriage. In the opinion of the Air Force specialists, wheels of the size envisaged by the project would not allow the aircraft to operate routinely from tactical dirt strips. The military insisted that the runway loading be reduced to the same level as on the IL-28. This entailed an increase in the size of the wheels which, in turn, made it impossible to stow them in the space between the spars of thin swept wings. In consequence, the chosen layout of the IL-54 had to be discarded.

In the new layout which was endorsed by Ilyushin on 16th November 1953 the aircraft was transformed into a shoulder-wing monoplane with normal low-set tailplanes mounted at the root of the vertical tail. The wings had 55° leading-edge sweepback; two wing fences were mounted on each wing. The aircraft was powered by two AL-7 engines with a maximum thrust of 8,600 kgp (18,960 lbst) apiece. As distinct from the original layout, the engines were placed in pylon-mounted nacelles under the wings. This arrangement was adopted after wind tunnel tests which had demonstrated that pylon-mounted engines offered less drag in transonic cruise.

To meet the military's demands regarding rough-field capability necessitating the use of bigger wheels, the designers opted for a bicycle undercarriage layout. It allowed the new, bigger undercarriage units to be stowed in the fuselage. Each of the two main units had twin wheels measuring 1,260 x 390 mm (49.6 x 15.35 in). Wheels of this size could not have been stowed in the thin wings or in the slim engine nacelles. The aft-retracting nose and main undercarriage units were placed fore and aft of the bomb bay and were spaced very widely; the rear unit was very far from the aircraft's centre of gravity. This precluded the possibility of normal rotation during take-off to increase the angle of attack before lift-off. To solve the problem, a special 'kneeling' mechanism was incorporated into the main (aft) undercarriage strut; during the take-off run it shortened the strut, making the aircraft lower its tail and thus increase the angle of attack. This resulted in a considerably shorter take-off run. Lateral stability on the ground was catered for by two auxiliary outrigger struts mounted at wingtips and retracting forward into special fairings.

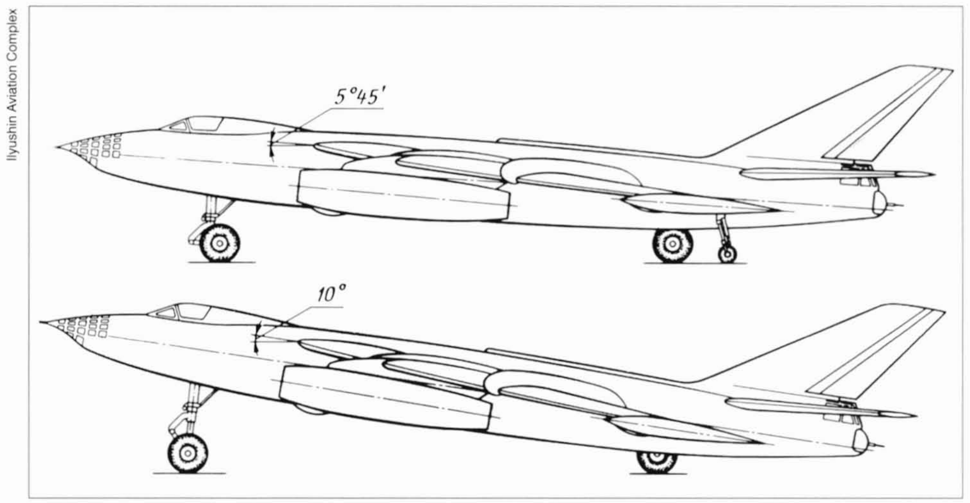
The IL-54's defensive armament comprised three 23-mm Afanas'yev/Makarov AM-23 (TKB-495A) cannon which were considerably superior to the NR-23 cannon used on the IL-28 and IL-46 as far as rate of fire and salvo weight were concerned. One cannon was mounted in a fixed installation on the port side of the forward fuselage; the other two formed part of the DK-35A remote-controlled tail turret operated by the gunner. The IL-54 could carry a maximum bomb load of 5,000 kg (11,025 lb).

On 3rd April 1955 the first IL-54 prototype commenced its manufacturer's flight test programme. The aircraft displayed good handling qualities, but its behaviour on the ground left something to be desired: the bicycle undercarriage proved tricky, espe-



Ilyushin Aviation Complex

Above: These drawings illustrating the original layout of the IL-54 show the main landing gear design and the sharply swept wings and tail surfaces.



Ilyushin Aviation Complex

This drawing shows how the 'kneeling' feature built into the main gear unit of the definitive IL-54 nearly doubled the angle of attack during take-off.

Ilyushin Aviation Complex

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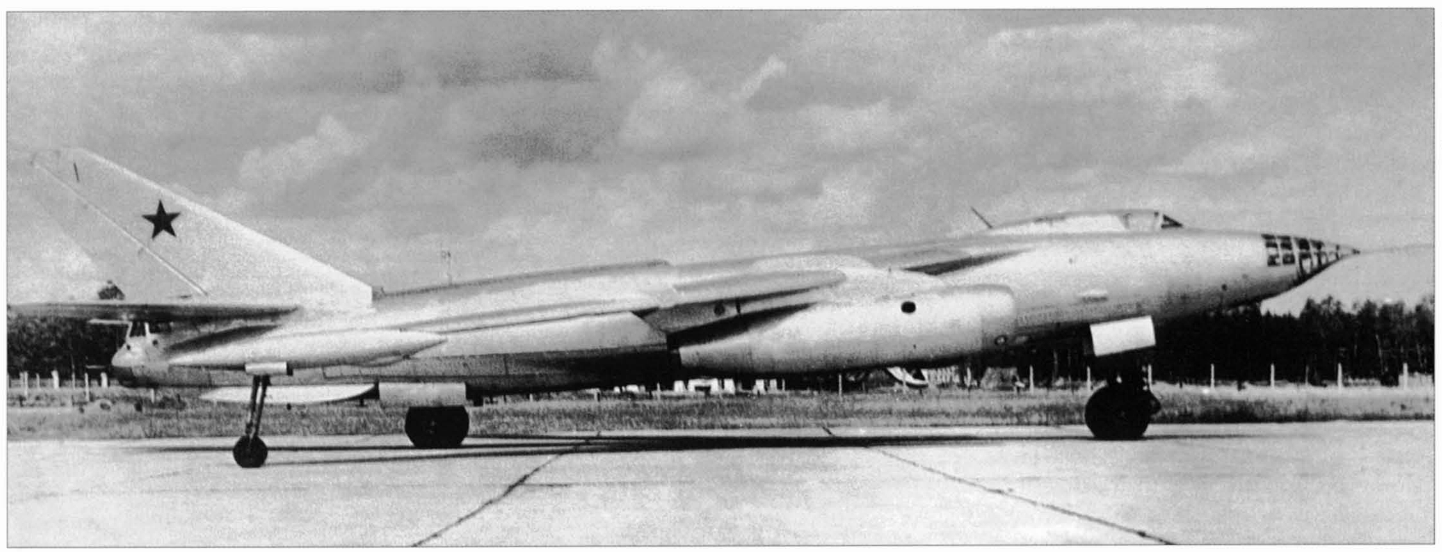

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Three shots of the second prototype IL-54 during trials (note the strakes under the rear fuselage). Unlike the graceful IL-28, this aircraft had an air of 'heavy metal' and brute force about it.

cially during landing run. Some improvements had to be incorporated into the undercarriage after an incident in which test pilot Kokkinaki lost control of the aircraft during the landing run; the aircraft made an abrupt turn on the runway resulting in some minor damage which was quickly repaired.

In spring 1956, the second machine made its appearance; it differed in being powered by two improved AL-7F engines (F = *forseerovannyy* – in this case, afterburning), each of them producing 10,000 kgp (22,050 lbst) of thrust in full after-burner. The new machine was equipped with two ventral strakes to improve directional stability.

In pursuance of a special resolution adopted by the Government on 2nd March 1954, the Ilyushin OKB developed several versions of the IL-54 intended for different missions (see description below). They were to be submitted for State acceptance trials in May 1955 (this deadline was revised later).

However, these versions were doomed to remain paper projects. The IL-54 failed to reach production status due to a number of reasons. One of these was competition from the Yakovlev OKB which was working on the Yak-26 – a derivative of the Yak-25 interceptor intended for the tactical bomber role. Aleksandr S. Yakovlev argued that his machine, while being smaller and lighter, could accomplish most of the missions envisaged for the IL-54. Another circumstance of importance in this case was the tendency of Soviet political and military leaders of that period to overestimate the role of missile systems to the detriment of aviation, which resulted in a diminished interest in conventional bombers.

The IL-54 was intended to be shown during the 1956 annual air display at Moscow-Tushino where it was to head a column of new prototype aircraft. However, shortly before that event the IL-54's participation in the Tushino airshow was cancelled. Instead, on 30th June 1956 it was shown to a US military delegation on the ground at Kubinka airbase west of Moscow, together with some other prototype aircraft. The delegation was headed by USAF Chief of Staff General Nathaniel F. Twining. This demonstration aroused much comment in the Western aeronautical press; Ilyushin's machine was assessed by Western observers as a transonic tactical bomber on a par with that time's state of the art. At that time the aircraft's true designation was not known, and it was given the NATO code-name *Blowlamp*. For a while it was ascribed the fallacious designation IL-140 (a drawing of the 'IL-140 Blowlamp' was published in 1959 in *Flieger* magazine). A source close to the Ilyushin OKB claims that the IL-54 was demonstrated at Kubinka AB under the designation IL-149.

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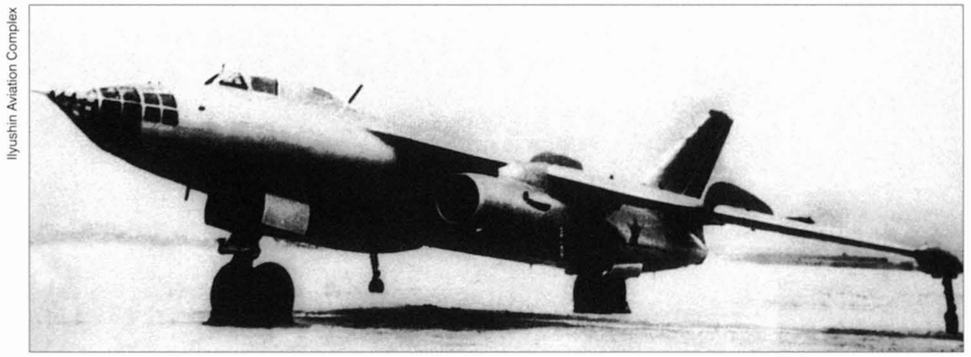
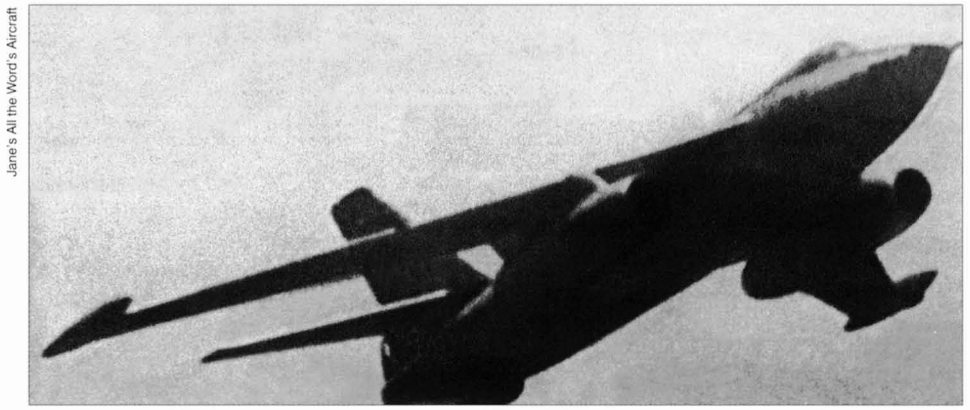


Above: The first prototype IL-54 lacked the ventral strakes.

Jane's All the World's Aircraft



A rare view of the second prototype IL-54 in flight.

The IL-54 was the last piloted bomber designed and built by the Ilyushin OKB.

Detailed below are the IL-54's project versions.

IL-54T torpedo-bomber (project)

One of the projected versions was the IL-54T torpedo-bomber which featured a bomb bay that was nearly 2m (6 ft 7 in) longer than that of the pure bomber version. It could carry two RAT-52 rocket-propelled torpedoes, two ordinary torpedoes of the 45-36MAV or 45-36MAN type (for high-altitude and low-altitude attacks respectively), mines and bombs (some documents state that the bomb bay of the IL-54T could accept *'all mines and torpedoes, with the exception of Type 45-36 and TAN-53 ship-borne tor-pedoes, the accommodation of which would necessitate a redesign of the bomb bay and a reduction of fuel tankage'*). The navigator's station contours were changed so as to provide better visibility for the navigator during low-altitude torpedo attack missions. Advanced development project of the IL-54T was endorsed by Ilyushin in May 1954. On 10th June 1954 the government adopted a new directive concerning the work on the IL-54T; it specified the AL-7F afterburning

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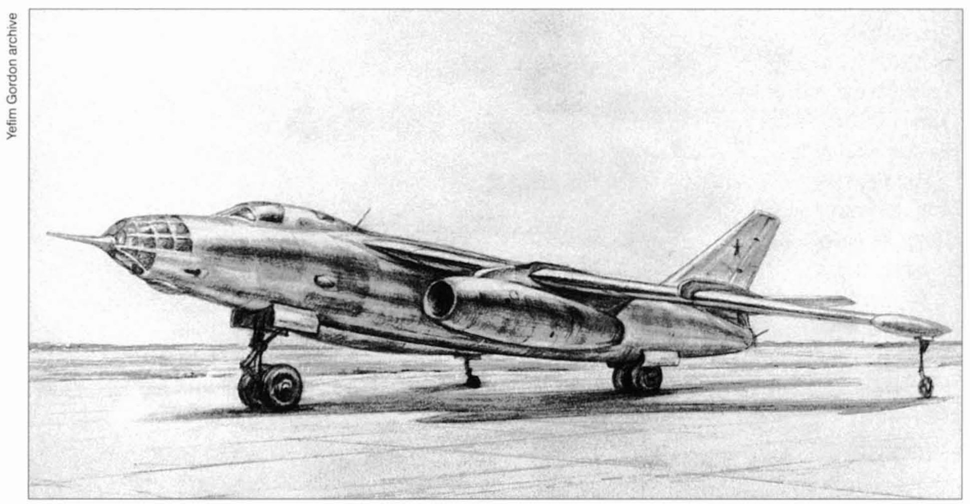
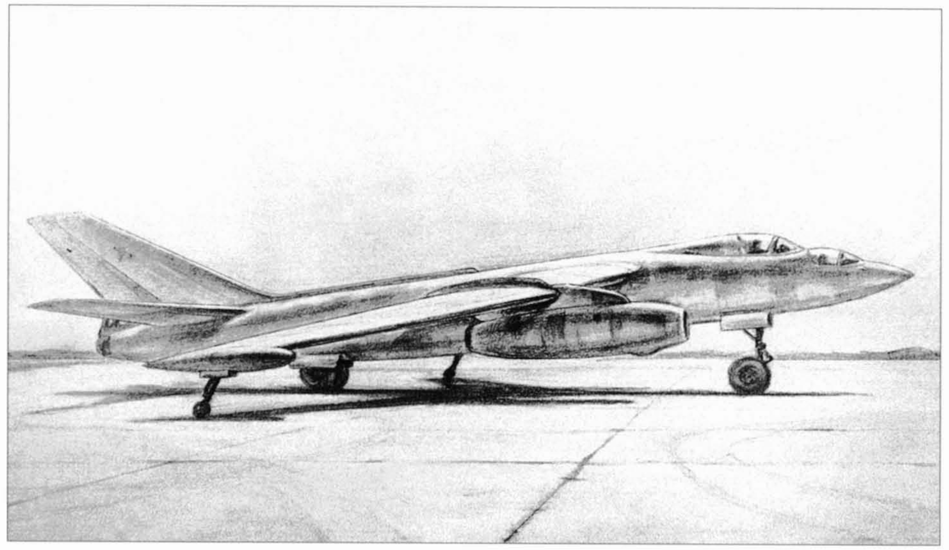


An artist's impression of the projected IL-54T torpedo-bomber. The reshaped nose glazing is clearly visible. Changing operational requirements overtook this aircraft before it could be built.



An artist's impression of the projected IL-54U trainer, showing the stepped-tandem cockpit arrangement. The shape of the nose is remarkably similar to the later Yak-28U trainer.

engines and stipulated that the aircraft was to be presented for State acceptance trials during the first quarter of 1956. However, the project failed to reach the hardware stage.

IL-54R photo reconnaissance aircraft (project)

Yet another 'paper' version was a photo-reconnaissance aircraft, the IL-54R. It was to be fitted with a complete set of photographic and other special equipment similar to that of the IL-28R reconnaissance aircraft. External differences (if any) between the IL-54R and the basic version are not known.

IL-54U trainer version of the IL-54 bomber (project)

A trainer version, the IL-54U, was envisaged; it carried no armament and featured an instructor's cockpit with a stepped windscreen placed ahead of the pilot's cockpit, replacing the navigator's station in a fashion similar to the IL-28U. (In passing, the later Yak-28U trainer looked almost like a 'baby IL-54U', except for the engine nacelles which adhered directly to the wing undersurface.)

IL-56 supersonic bomber (project)

Concurrently with the construction and testing of the IL-54 prototype, preliminary studies were conducted by the Ilyushin design bureau with a view to defining the configuration of a new supersonic tactical bomber designated IL-56. This work was effected pursuant to the joint directive of the Communist Party Central Committee and the Government dated 28th March 1956 which required General Designer Ilyushin and the Ministry of Aircraft Industry (MAP) to submit in June 1956 their proposals concerning the deadline for prototype construction and its submission for State acceptance trials. The basic specifications envisaged a maximum speed of Mach 1.75 to 1.9, a bomb load of 2,000 kg (4,410 lb) and a range of 2,200 km (1,367 miles). An MAP order contained such figures as a speed of 1,700-1,800 km/h (1,057-1,119 mph), a service ceiling of 14,000-15,000 m (45,930-49,210 ft) and an all-up weight of 23,000-24,000 kg (50,715-52,920 lb). Various layouts were considered; some of them were based on the use of a single AL-7F engine, while others involved the installation of two Mikulin AM-11 afterburning turbojets under development at that time. Finally, the designers opted for the twin-engined configuration. The IL-56 was a two-seat high-wing monoplane with low-set tailplanes and a bicycle undercarriage. Semi-circular air intakes featuring movable centrebodies in the form of a half-cone were placed on top of the fuselage in the area of the wing centre section. The wings had a sweepback angle of 45° to 55° (in different versions of the basic configuration). Experiments with models were conducted in the TsAGI wind tunnel in 1955-56, but in early 1956 the OKB had to terminate all work on the IL-56. The resources of the OKB were to be concentrated on a new assignment – the development of a cruise missile (or 'unmanned winged missile', as it was termed at that time).

Specifications of the IL-54 transonic tactical bomber

	IL-54 first prototype	IL-54 second prototype
Year	1954	1955
Crew	3	3
Wing span	17,65 m (57 ft 11 in)	
Length overall	28,963 m (95 ft ¼ in)	
Wing area, m² (sq ft)	84.6 (910.7)	
Engine type	AL-7	AL-7F
Engine thrust, kgp (lbst):		
maximum	2 x 7,700 (2 x 16,980)	2 x 10,000 (2 x 22,050) *
nominal	2 x 6,500 (2 x 14,330)	2 x 6,500 (2 x 14,330)
Weights, kg (lb):		
AUW, normal	40,400 (89,078)	40,660 (89,655)
AUW, maximum	41600 (91,728)	41,600 (91,728)
empty weight	26,505 (58,443)	24,000 (52,920)
Maximum speed, km/h (mph):		
at sea level	n.a.	1,155 (718)
at 5,000 m (16,400 ft)	1,100-1,150 (683-715)	1,250 (777)
Landing speed, km/h (mph)	n.a.	243 (151)
Time to 5,000 m, minutes	3.3	n.a.
Service ceiling, m (ft)		14,000 (45,930)
at nominal trust	11,500 (37,730)	n.a.
at max thrust	13,630 (44,720)	n.a.
Range, km (miles)		2,500 (1554)
without drop tanks	2,057 (1,278)	n.a.
with drop tanks	2,312 (1,437)	n.a.
Bomb load, kg (lb):		
normal	3,000 (6,615)	3,000 (6,615)
maximum	5,000 (11,025)	5,000 (11,025)
Take-off run	1,150 (3,773)	1,075 (3,527)
Landing run	n.a.	1,150 (3,773)
Defensive armament	3 x NR-23	3 x NR-23

* in full afterburner

3 PISTON-ENGINED AIRLINERS AND TRANSPORTS

IL-12 4M-88 airliner (project)

In 1943, when the Great Patriotic war was at its height, a new direction began to take shape in the creative activity of the design collective led by Sergey V. Ilyushin. Eventually this new direction – passenger and transport aircraft design – became one of the main aspects of the OKB's activities.

Although in the middle of the war period the Soviet aircraft industry concentrated all its efforts on the manufacture of combat aircraft, Sergey V. Ilyushin on his own initiative began design work on a passenger aircraft with performance characteristics which, in his view, would meet the requirements of the Civil Air Fleet's post-war development to the greatest extent. Fully realising the complexity of the task of creating a good airliner, Ilyushin sent a small group of prominent specialists of the OKB to Tashkent where the Li-2 (a licence-built Soviet derivative of the Douglas DC-3 airliner) had been in production since 1941. The group's task consisted of studying the special features of the Li-2 and the methods of its manufacture. Making use of the new knowledge thus acquired and of the experience accumulated in the course of ten years of combat aircraft design, the OKB began work on the first passenger aircraft in its practice (true, there had been a project of a passenger version of the BB-2 – the future DB-3 bomber, but it never progressed further than the initial studies).

During this period two distinct approaches to designing new passenger aircraft emerged. The adherents of the first one (they included many foreign aircraft manufacturing companies) wished to build new airliners by redesigning the medium and heavy bombers that had proved their worth in combat (the Yermolayev Yer-2, Petlyakov Pe-8, Boeing B-29, Convair B-24, Avro Lancaster and the like). Creating a passenger aircraft on the basis of a bomber's airframe made it possible to save time and cut development costs, but post-war operational experience with these airliners demonstrated their relatively low economic efficiency, and these machines were fairly quickly phased out of production during the early post-war years.

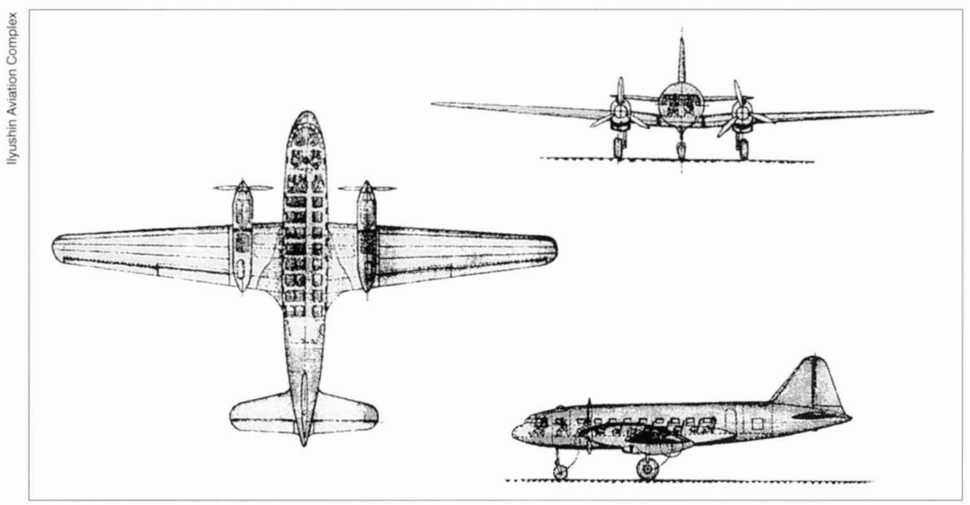
Ilyushin opted for a different approach. The process of designing the IL-12 was aimed at solving the task of providing the country's national economy with a modern means of transport that would be intended for wide use over a lengthy period, and would be safe, economically efficient and compatible with the available airports and their ground handling and maintenance equipment. This approach dictated the creation of a dedicated passenger aircraft with characteristics optimised for performing definite transport duties. This aircraft was to incorporate the latest achievements in the fields of aerodynamics, aircraft engines, avionics, aviation materials, production methods – in short, in everything that is of crucial importance for the airliner's level of technical sophistication, its operational efficiency and profitability. This approach, as demonstrated by subsequent experience, gained a predominant position in the development of new airliners.

One of the main peculiarities of the IL-12's design process was the absence of any operational requirements set forth by the customer (Aeroflot, the Soviet state airline) for this aircraft. The designers sought to ensure maximum flight safety, passenger comfort and high economic efficiency, but they had no precisely formulated operational criteria that would dictate the machine's configuration, such as seating capacity, range, cruising speed, runway length and the bearing strength of the runway surface. All these criteria emerged in the OKB in the process of design work; as these criteria were defined more accurately, the preliminary design studies underwent fairly substantial changes.

Sergey V. Ilyushin was of the opinion that the post-war development of the Soviet Union's national economy would be accompanied by a steady growth of the passenger and cargo traffic volumes. Accordingly, the new aircraft's seating capacity, its payload, cruising speed and especially the range ought to be superior to those of the Li-2; at the same time the new machine should be capable of operating from the same airfields as used by the Li-2.

The first version of the IL-12, the work on which started in the autumn of 1943, was to have 29 passenger seats. In accordance with the requirements of that period, the entry door to the passenger cabin was located on the starboard side of the fuselage. As regards the level of passenger comfort and the seat pitch, the passenger cabin of the IL-12 met the standards for first-class seating arrangements.

Range with a load factor of 50% (that is, 14 passengers) was expected to be 5,000 km (3,108 miles) at a cruising speed of nearly 400 km/h (249 mph). These performance characteristics were high for their time; fully taking into account the special features of the Aeroflot routes that were in existence at the time, they enabled the new aircraft to make non-stop flights on most of the routes which linked major industrial and adminis-



A three-view of the IL-12 from the project documents, showing the pointed nacelles housing ACh-30B diesels and aft-retracting single-wheel main landing gear units. The aircraft is configured for 27 passengers.

trative centres of the country, and to fulfil various transport tasks alongside the available fleet of Li-2s.

In order to attain the estimated performance characteristics, the project incorporated a number of unorthodox design features. First of all, the original project version of the IL-12 envisaged a high-altitude aircraft with a cruising altitude of 6,000-7,000 m (19,685-22,960 ft). At this altitude the air is considerably thinner than at sea level, resulting in lower drag; in consequence, the aircraft's speed and range can be increased provided the necessary engine power rating is retained at this altitude. Flight safety and regularity of flight operations are likewise enhanced: as a rule, flight at high altitudes takes place under more favourable weather conditions with a reduced probability of icing.

To achieve all this, it was planned to equip the first version of the IL-12 with four M-88V radials (V = *vy**sot**nyy* – high-altitude) driving three-bladed propellers. The M-88V was a derivative of the M-88B that had proved their worth in the long-range flights of the IL-4 bombers powered by a pair of these engines. A powerplant based on the use of an engine that had undergone a lengthy development and possessed good fuel efficiency and a long service life would ensure for the new airliner not only a high level of flight safety (among other thing, in the event of a single-engine failure on take-off) but also the required economic efficiency. The reliability of the M-88V was further enhanced by the fact that this engine did not use a turbosupercharger as a means of preserving the required power at high altitude (turbosuperchargers were still afflicted with teething troubles); instead, it utilised a new mechanically-driven centrifugal supercharger which had been perfected on the M-89 engine. With this supercharger the M-88V retained its nominal power rating of 1,000 hp up to the altitude of 7,300 m (23,950 ft).

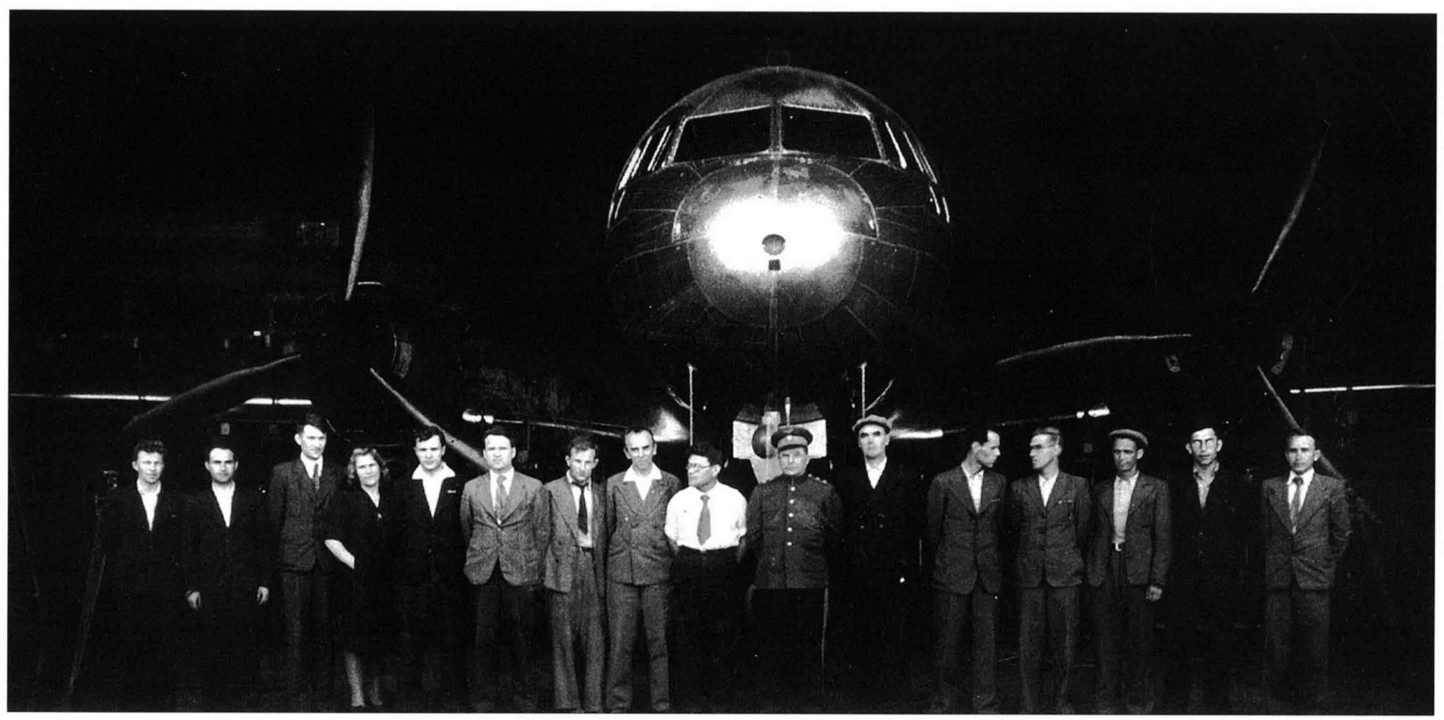
The crew and passengers were accommodated in a pressurised fuselage; the air required for pressurisation was tapped from the engine compressors. The forward fuselage contours of the IL-12 were characteristic of Ilyushin's design style. The nose had a parabolic shape and was blended fully into the fuselage contours in a manner similar to the Boeing 307 Stratoliner (the world's first airliner to feature a pressurised cabin); the flightdeck glazing did not disrupt this shape which was ideally suited for sustaining the stresses resulting from the pressure differential in the pressurised cabin. Virtually all structural elements and, above all, the skinning of the fuselage nose, were subjected to tensile stresses and their strength could be easily calculated. A hemispherical pressure dome was placed at the rear end of the pressure cabin in the tail section of the fuselage.

One more special feature of the IL-12 project was the fact that, for the first time in the OKB's practice, it made use of a tricycle undercarriage. At that time this undercarriage layout was very rarely used on aircraft of this class; in the USSR it had been implemented, shortly before the start of design work on the IL-12, by Vladimir M. Myasishchev on his DVB-102 bomber prototype. To prevent the rear fuselage from scraping the ground in the event of over-rotation on take-off or a tail-down landing, it was to be fitted with a small wheel semisubmerged in the fuselage. The nosewheel undercarriage ensured higher safety during take-off and landing, especially in adverse weather conditions. The level position of the fuselage when the aircraft was parked afforded a greater degree of passenger comfort.

The project of the high-altitude version of the IL-12 powered by four M-88Vs was endorsed by Sergey V. Ilyushin on 4th January 1944. In the same month a report on this project was submitted to Stalin. He supported Ilyushin's initiative and gave his approval for the work on the IL-12.

IL-12 airliner prototype with ACh-31 diesel engines

Subsequently the project of the IL-12 airliner underwent substantial changes. As early as the end of January 1944 studies were initiated for a twin-engined version of the aircraft powered by Charomskiy ACh-31 liquid-cooled Vee-12 diesel engines with a two-phase fuel/air mixture forming process which, as evidenced by the tests of the IL-6 bomber prototype, ensured a considerably more reliable operation of the diesels. (According to some documents, in October 1944 the initial version of the twin-engined IL-12 was referred to as the IL-12 ACh-30B; presumably the ACh-31 was a development of this engine).The engines with a take-off rating of 1,900 hp were housed in pointed nacelles, while their coolant radiators were accommodated in the wing centre section leading edge; in consequence, the wing centre section acquired the forward extension of the chord so characteristic of the IL-12 in plan view.



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The only available photo of the IL-12 prototype as originally flown with ACh-31 diesels. The aircraft is pictured at the OKB's experimental shop at Moscow-Khodynka, with the OKB's design staff posing in front of it; Sergey V. Ilyushin is in the centre in his military uniform.

Installation of the new engine forced the designers to give up some of the features that had been adopted for the IL-12 4M-88V. It was difficult to tap a large amount of air for cabin pressurisation from the diesel engines which required powerful turbosuperchargers or centrifugal superchargers for their normal operation even at relatively low altitudes. In consequence, the twin-engined version of the airliner was no longer regarded as a high-altitude aircraft; it came to be classed as a suited passenger aircraft for medium altitudes. Despite the increased fuel efficiency of the diesels, their higher specific weight (nearly 50% greater than that of the M-88V), smaller total power output of the powerplant at the rated altitude, and lower operating altitude determined the lower speed and shorter range of the twin-engined version in comparison with the original project.

The number of passenger seats installed in the cabin of the twin-engined aircraft was reduced to 27. The contours of the forward fuselage/flightdeck section were also altered. Since the cabin was no longer pressurised, the designers opted for the traditional forward fuselage shape with a stepped windscreen which had become classic for airliners. Sergey V. Ilyushin always paid great attention to flightdeck design, proceeding from the very correct assumption that the huge responsibility for the safety of passengers made it imperative that the crew be provided with spacious and comfortable work stations affording excellent visibility of the surrounding space and of the instrument panels. Aspiration for providing the best possible work conditions for the crew can be traced in all passenger and transport aircraft designed by the OKB; it came to the fore for the first time during the projecting of the IL-12, the flightdeck of which was made considerably more spacious and comfortable than that of the Li-2.

In March 1944 Ilyushin endorsed the general layout and overall configuration of the twin-engined IL-12 powered by ACh-31 diesels. The OKB started preparing the advanced development project; the emphasis in this work was placed on creating a highly reliable and safe airliner. In this context particular attention was devoted to evolving, together with TsAGI, the aerodynamic layout of the wings and to measures enabling sustained flight with one engine inoperative. Guided by the wish to develop for the IL-12 wings with high aerodynamic efficiency in all operation modes, the specialists of TsAGI and the OKB conducted comprehensive theoretical and experimental studies of different wing aerodynamic configurations; on the basis of these studies they developed wings of high aspect ratio and moderate taper; the air flow around the extreme outer panels was free from separation. A special feature of the IL-12's aerodynamic wing layout was also that, unlike other contemporary airliners, the wing was designed for cruising speeds, not for the maximum speed (the best lift values were obtained at the cruising speed). Coupled with the specially selected propellers whose maximum output also corresponded to the cruise mode, this ensured for the IL-12 a high ground speed and high economic efficiency.

Attaining a high level of aerodynamic perfection in design was not enough to solve completely the flight safety problem. It was also necessary to ensure that the aircraft would be capable of performing a protracted flight with a full payload in the case of an engine failure. In the USSR this problem was solved for the first time in the course of designing the IL-12. Concurrently measures were taken to ensure trouble-free functioning under these conditions of all the basic systems and of the aircraft's flight, navigation and radio communication equipment.

Safety and dispatch reliability and, consequently, the economic efficiency of a passenger aircraft for medium altitudes (to which class the IL-12 was converted at the advanced development project stage) depended to a large extent on the reliability and operational simplicity of its anti-icing system. In 1944 the main type of de-icing device for the protection of wing and tail unit leading edges of passenger aircraft was the mechanical de-icer developed by the US company BF Goodrich. This de-icer widely used on the DC-3, PS-84 (Li-2) and C-47 aircraft, among other things, consisted of rubber boots bonded to the wing and stabiliser leading edges. Inside the boots there were sections which were alternately inflated by compressed air from the engine superchargers and deflated. Other aircraft used thermal anti-icing systems which used self-contained heaters, the so-called gasoline stoves, as a heat source.

Sergey V. Ilyushin took the decision to concentrate the main efforts on developing for the IL-12 an anti-icing system using engine exhaust gases. This system was simpler than the BF Goodrich-type pneumatic de-icer boots and considerably safer in terms of fire hazard than gasoline heaters. On the IL-12 the anti-icing system featured direct heating of the leading-edge skin by a mixture of exhaust gases and ambient air. Anti-icing was also provided for some other parts of the aircraft.

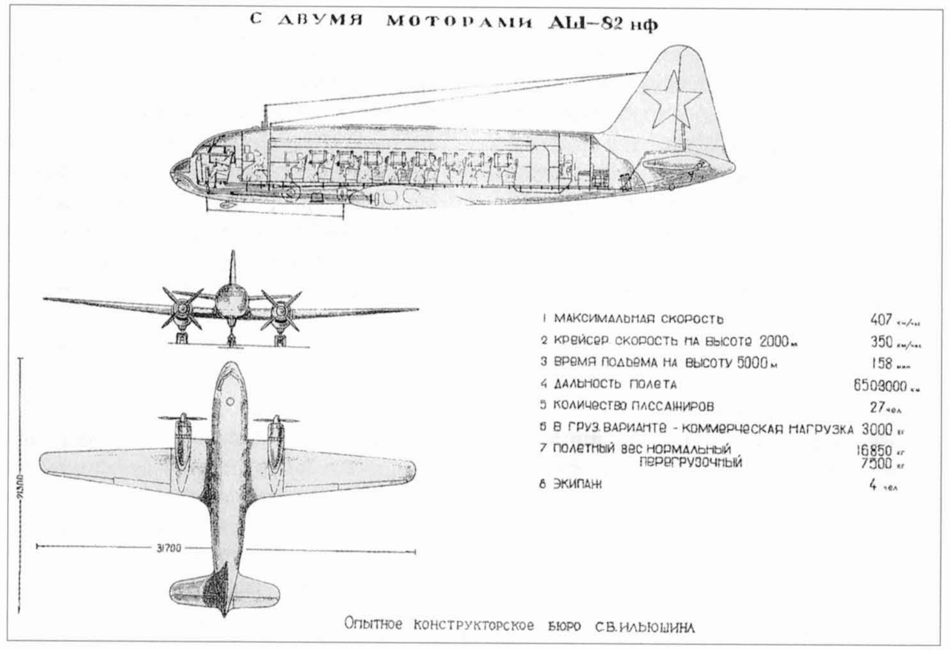
In projecting the IL-12 special attention was paid to minimising the fire hazard. Measures were taken to exclude any leaks of fuel and oil. The planned installation of diesel engines using kerosene as the main fuel led the designers to take extra care in the sealing of fuel piping because in the case of the slightest leak the kerosene with its low evaporation ability not only soaked the surrounding structural elements but also crept on to farther places of the aircraft, thus creating an enormous fire hazard. The experience gained in projecting and operating the diesel-powered IL-6 on which the OKB had developed new methods of sealing the piping of the kerosene fuel system helped tackle this problem. In addition to preventive measures, various fire suppression systems were to be installed in the IL-12, both in the engine nacelles and in the passenger cabin.

The ADP of the diesel-engined version was completed by the autumn of 1944. An unofficial mock-up review commission which included representatives of the State Civil Air Fleet Research Institute (GosNII GVF – *Gosoo**dar**stvennyy na**ooch**no-is**sle**dovatel'skiy insti**toot** Grazh**dahn**skovo voz**doosh**novo **flo**ta*) gave a high appraisal to performance, design features and operational qualities of the airliner. Some critical remarks of the Civil Air Fleet specialists, such as the suggestion that the pneumatic landing gear retraction system be replaced with a hydraulic one, were accepted and later implemented during the construction of the prototype which was completed in the summer of 1945.

The IL-12 powered by ACh-31 diesels made its maiden flight on 15th August 1945. Several flights performed by test pilots, brothers Vladimir and Konstantin Kokkinaki under the factory test programme revealed the need for comprehensive and lengthy development work on the prototype ACh-31 engines with a view to bringing them fully up to the standards stipulated for the powerplants of passenger aircraft.

IL-12 prototype with ASh-82FN engines

The prospects of the IL-12 powered by the ACh-31 diesels became uncertain: the planned dates for the completion of manufacturer's tests and State acceptance trials and for putting the IL-12 into scheduled service on the USSR's air routes were put in jeopardy. It could turn out that the efforts designed to bring the diesels up to the required standard would prove of no avail and the country would not receive the much-needed new airliner in time. In this situation Sergey V. Ilyushin took the difficult decision to replace the diesel engines with engines running on gasoline which had the advan-



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Above: A diagram of the radial-engined version; curiously, the engine type is stated as 'ASh-82NF' instead of 'ASh-82FN'. Note that the cutaway side view represents the military troopship version.

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Centre and above: The prototype IL-12 following conversion to take the ASh-82FN radials; the aircraft was totally devoid of markings. The new forward-retracting twin-wheel main gear units are clearly visible.

tage of being more reliable, well-developed and possessing a long service life. This change had to be made at the expense of some reduction in performance, especially range. Proceeding from his conviction that trouble-free operation of the powerplant was one of the most important prerequisites for flight safety, Ilyushin opted for the Shvetsov ASh-82FN two-row 14-cylinder air-cooled radial delivering 1,850 hp for take-off. This was a production engine which was widely used on Soviet fighters and bombers. Its characteristics with regard to reliability, service life and fuel efficiency could quickly be brought up to the level stipulated for passenger aircraft, and the absence of liquid cooling made it possible to considerably simplify maintenance and reduce the pre-flight preparation/turnaround time, especially in the winter. The expediency of the decision taken by Ilyushin was borne out by the results of wind tunnel tests of an IL-12 model configured with the new engines. The tests conducted in the TsAGI wind tunnels showed that replacement of the diesels with air-cooled engines did not introduce any appreciable changes into the aircraft's aerodynamic characteristics.

Flight testing of the IL-12 prototype was suspended; within a very short period the airframe was subjected to modifications associated with the installation of the new engines, and modification of the flaps and main undercarriage units. The main gear units were redesigned to enhance the aircraft's ability to operate from dirt runways. The large single wheels were replaced with twin wheels of a smaller diameter; also, the main gear units now retracted forwards instead of aft, the wheels being completely enclosed by doors (the original single wheels were semi-exposed when retracted). This redesign made emergency undercarriage extension much more reliable because the main legs, once released from their locks, would be forced into the extended position by the slipstream. The new engine nacelles no longer protruded beyond the wing trailing edge, making it possible to eliminate a gap between the flap sections and to increase the overall area of the flaps. The wing lift at low speeds was thereby increased.

Despite the deletion of the coolant radiators, the aircraft retained the increased chord of the wing centre section with no sweepback on the leading edge.

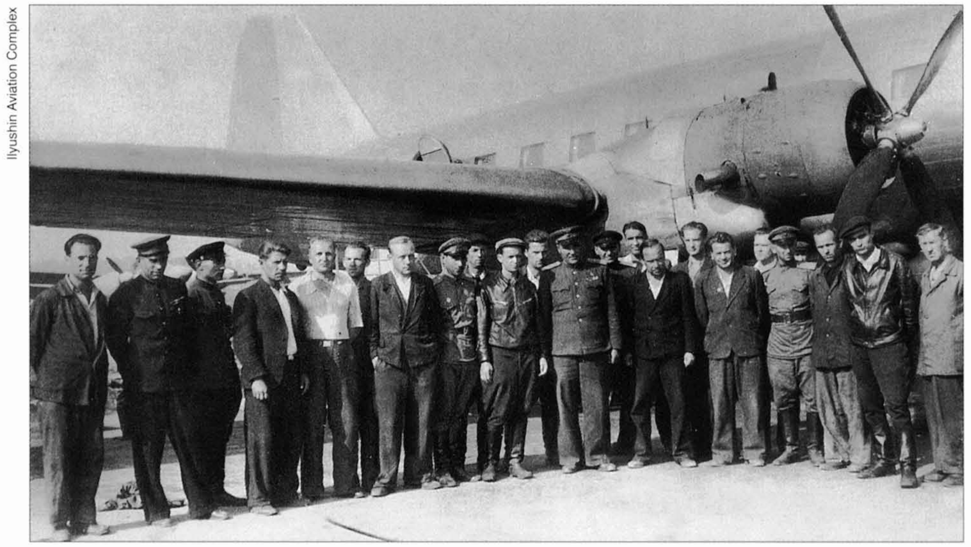
On 9th January 1946 the converted prototype IL-12 made its 'second maiden flight' with ASh-82FN engines, piloted by captain Vladimir K. Kokkinaki and first officer Konstantin K. Kokkinaki. A major nuisance during the first flights was the violent vibration of the new propellers developed specially for this machine. The cause was traced to insufficient rigidity of the blades; it proved necessary to conduct tests of three versions of propellers before the vibrations were eliminated. On the whole, the manufacturer's tests showed that OKB-240 succeeded in creating a high-speed airliner with performance, stability and controllability characteristics considerably superior to those of the Li-2 and Douglas C-47.

State acceptance trials of the prototype IL-12 powered by the ASh-82FN engines started on 1st July 1946. They were conducted by a commission headed by Chief of NII GVF, Air Lieutenant-General I. F. Petrov. The aircraft was submitted for the State trials in a 27-seat configuration with an AUW of 16,380 kg (36,120 lb) and a range of 1,300 km (808 miles) with no reserves. The trials of the IL-12 was conducted by NII GVF test pilots G. A. Taran and A. I. Voskanov; they were successfully completed on 16th September 1946. The test results and the experience of IL-12 operations on Aeroflot's routes showed that there was potential for a further increase of the AUW and a corresponding increase of payload and range with the resulting improvement of economic efficiency.

To increase the range, the Chief Designer endorsed the AUW of the aircraft at 16,800 kg (37,040 lb) in the normal configuration and 17,500 kg (38,590 lb) in overload configuration. Additional testing of an IL-12 with the increased AUW conducted in the autumn of 1946 revealed that the IL-12 was considerably superior to the passenger aircraft operated on scheduled services at that time. The IL-12's cruising speed exceeded that of the Li-2 by 100 km/h (62 mph). With its bigger payload and higher cruising speed, the IL-12 ensured a lower cost per tonne-kilometre than the Li-2 and Douglas C-47.

At an AUW of 16,800 kg the aircraft could perform sustained flight with one engine inoperative; it had enough extra power for climbing to 2,500 m (8,200 ft) on one engine. At the overload weight of 17,500 kg the IL-12 also could perform a flight on one engine.

A check-up of the aircraft's field performance conducted at airfields of different dimensions and with different types of surface corroborated that the IL-12 could operate from the same Aeroflot airfields as the Li-2.



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Above: A group of OKB-240 engineers beside the re-engined IL-12 prototype; Sergey V. Ilyushin is 12th from left.

Pre-production IL-12 airliner

The high appraisal given to the new aircraft by the factory test pilots prompted the decision to launch production of the IL-12 even before the commencement of the State acceptance trials. The aircraft was to be built at Plant No.30; the personnel of this plant headed by its director P. A. Voronin were extremely quick in switching over from attack aircraft production to the production of an airliner. Tooling-up for the manufacture of the new type proceeded at such a high tempo that by the time the State acceptance trials were due to commence the series production of the aircraft was already under way in all workshops of the plant. This made it possible to launch full-scale production very quickly and speed up the introduction of the new airliner into scheduled service.

By the beginning of 1947 five IL-12s of a pre-series batch were handed over for evaluation to the Independent Air Group of the Civil Air Fleet (GVF) based at Vnukovo airport (Moscow). The tests conducted under the guidance of Hero of the Soviet Union G. A. Taran were completed successfully. The high performance and good operational qualities of the IL-12 found their confirmation during a non-stop flight from Moscow to Tashkent over a distance of 2,820 km (1,753 miles), flights over the mountain ranges of the Caucasus and Central Asia at altitudes up to 6,500 m (21,320 ft), a take-off from the high-elevation airfield in Yerevan at an AUW

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The still unregistered IL-12 prototype with ASh-82FN engines in a test flight in the vicinity of Moscow. Note the direction finder loop aerial in a teardrop-shaped fairing ahead of the wing leading edge. The different colour of the rudder is due to the fact that it is fabric-covered.

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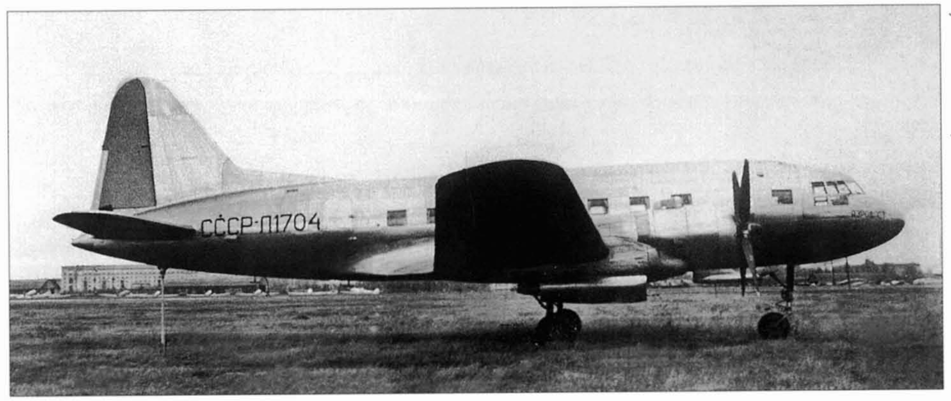
Above: The unmarked second prototype of the IL-12T military transport (c/n 30064) during State acceptance trials; note the port side cargo door and the external stores racks under the inner wings.



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Above: СССР-Л1704 (ie, SSSR-L1704), an Aeroflot IL-12B. The fin fillet characteristic of the B version is clearly visible. This example is devoid of any kind of livery.

of 17,200 kg (37,926 lb) and other complicated flights.

Aeroflot pilots had a high opinion of the new airliner. They praised its spacious flight-deck and comfortable work stations; the machine's stability during take-off and landing in normal conditions and in a crosswind, the good speed range, the high power/weight ratio and good rate of climb which enabled the aircraft to quickly break through clouds and through the ice hazard zone. The reliable engine operation in the ice hazard zone was also noted, as were the stability in instrument flight, the aircraft's pleasant handling and docility even at speeds close to the landing speed. Pilots emphasised that the IL-12 was easy to fly and conversion of the flying personnel from the Li-2 to the IL-12 would present no difficulties. The pilots were also quick in mastering the technique of piloting the aircraft with one engine out.

During the evaluation period the IL-12 was flown experimentally at an AUW of 18,200 kg (40,130 lb). The pilots noted that in this case the piloting was more complicated only from the moment of lift-off to the moment of acceleration to 175 km/h (109 mph), when the aircraft showed some instability, and during landing (because of a considerable sink at the moment of flareout). On the basis of experience gained in flying the IL-12 under diverse conditions, the normal AUW in regular operations was established at 17,250 kg (38,040 lb) at the recommendation of NII GVF.

The pilots quickly mastered formation flights, and on 1st May 1947 a group of IL-12s for the first time took part in the May Day flypast over the Red Square.

IL-12 production passenger aircraft

The plant chosen for IL-12 production (MMZ No.30 'Znamya Truda') was destined to be the sole enterprise manufacturing the IL-12. In 1947 the output reached 183 aircraft, increasing to 258 units in 1948 and 215 in 1949. In all, together with the five pre-production machines, 663 IL-12s were manufactured. The NATO reporting name was *Coach*.

Production machines featured several passenger cabin configurations, depending on the range. The main variant had 27 passenger seats, but there were also machines with a shorter range which had 32 seats.

The IL-12's service introduction was anything but uneventful. One summer morning in 1947 crew captain V. Chernikov, having taken on board 40 schoolchildren who were travelling to a pioneer camp on the Black Sea coast, taxied the aircraft to the line-up point. The aircraft had already begun the take-off run when, at a speed of 100 km/h (62 mph), the port engine cut. The captain chose to abort the take-off, and disaster was averted. But later, in the summer of 1949, the events took a bad turn. A delegation of women from Norway was coming back to Moscow from Stalingrad; their aircraft crashed near Voronezh, killing all on board, after one of its engines had caught fire.

This tragedy became a matter of much concern in both countries. A government commission was immediately sent to Voronezh. The 'tin kickers' came to the conclusion that the engine fire as such might not necessarily have led to a crash; however, the fire ignited the rear cover of the engine nacelle which was made of a magnesium alloy. This produced a powerful high-temperature jet of flame which sliced through the wing spars like the flame of a gas burner, causing the wing to break away.

The investigation results, as well as the IL-12 deficiencies that had been revealed in airline service, were reported to Iosif V. Stalin by Gheorgiy F. Baidukov, head of the Chief Directorate of the Civil Air Fleet (GU GVF – ***Glahv****noye oopravl***en***iye grazh***dahn***skovo vozd***oosh***novo* ***flo****ta*). On 9th October the Government issued a directive tasking Sergey V. Ilyushin with curing the defects of the IL-12 within the shortest time possible. All magnesium parts were eliminated from the engine nacelle structure and replaced by aluminium alloy parts. In addition, the fire suppression system in the engine bays was redesigned. Its efficiency was tested on a special full-scale engine nacelle test rig where different scenarios of a fire breaking out were reproduced to check the reliability of the extinguishing techniques.

Boris Vdovenko

Passengers board IL-12 *sans suffixe* СССР-Л1411 (c/n 30147) at Moscow-Vnukovo, with a sister ship and Li-2Ps in the background. Note the fuselage pinstripes, the coloured fin cap and the support under the tail.

Operational experience with the IL-12 was carefully studied by various design departments of OKB-240 which were busy curing the faults that had come to light. The main direction of perfecting the IL-12 was enhancing the safety in the event of an engine failure during the take-off. In the second half of the 1940s neither military nor civil twin-engined aircraft were capable of continuing the take-off at any point of the take-off path in the case of an engine failure. During take-off there was a dangerous zone which started at V_1 (the speed beyond which it was no longer possible to abort the take-off due to insufficient remaining runway length) and ended when the aircraft attained a speed 25-30% higher than the stalling speed. Although an aircraft passed this dangerous zone in the course of 15-20 seconds, an engine failure happening at this moment could end in a crash.

To enhance the safety of take-off and cruise flight with one engine inoperative, after the Voronezh crash the IL-12's AUW was temporarily limited to 16,100 kg (35,500 lb). The wish to retain the same range as before dictated the need to limit the payload. From then on the IL-12s were operated only in the 18-seat basic layout. The additional space which became available in the forward part of the cabin was used for baggage/cargo stowage. Subsequent operations showed that the imposition of this limitation was a mistake; the limitation was lifted, and from early 1954 onwards the basic interior layout of the IL-12 featured 21 seats.

GosNII GVF conducted additional tests of a production example of the IL-12 with a view to evolving the piloting techniques for a situation when an engine failure occurred at take-off. The flights were performed from a natural hardened clay flat area near Ashkhabad, the dimensions of which made it possible to conduct such flights with a minimum of risk. A crew captained by GosNII GVF Vice-Director Ivan P. Mazuruk, a well-known Polar Aviation pilot, successfully performed the tests which abounded in critical situations. The tests made it possible to work out recommendations for techniques designed to ensure safety when performing a single-engine take-off. However, they did not solve this problem completely: experience had shown that an engine failure at take-off after the lift-off, when the aircraft still has a relatively low sped of 175-180 km/h (109-112 mph), caused the greatest difficulties in piloting because of a sharp reduction in controllability: the pedal forces reached 80-85 kg (176-187 lb). To reduce these forces, one production IL-12 was fitted with a new rudder featuring a spring tab. This made it possible to reduce the pedal forces after an engine failure at take-off to less than half of the previous value. At the same time a dorsal fin was added, which helped increase directional stability in cruising flight and make piloting in a turbulent atmosphere more comfortable.

The use of a rudder fitted with a spring tab made it possible to recommend the pilots to perform a take-off always with the engines at the take-off power setting (or the boosted setting, in the parlance of those days). Prior to that, on the IL-12 featuring a rudder with a normal trim tab, pilots performed a take-off under normal circumstances, using a nominal engine power setting. Although the take-off power setting provided an extra 640 hp, it was not used in practice because of the large pedal forces in the event of an engine failure.

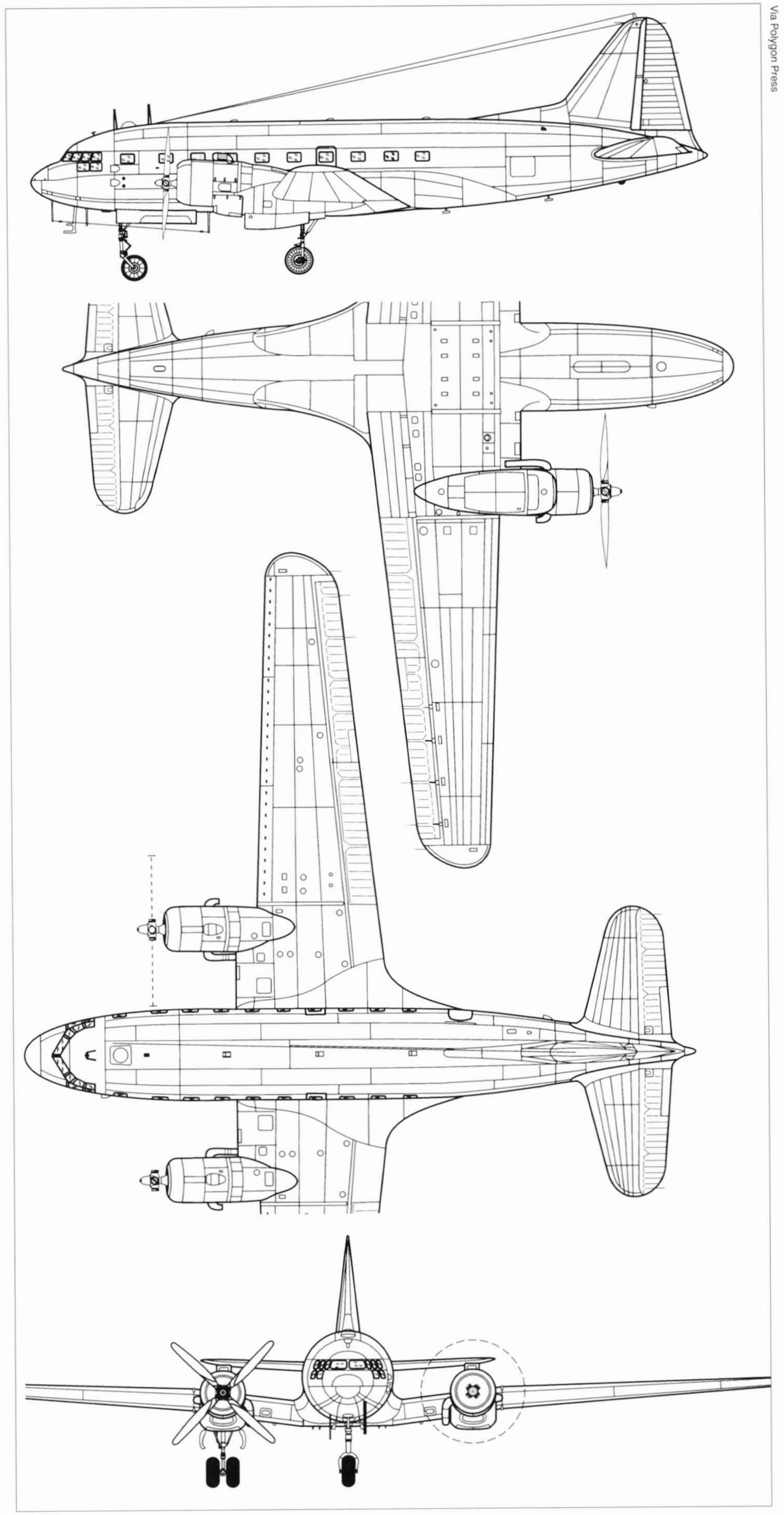
The available engine power of the IL-12 at take-off was also increased by means of altering the system controlling the carburettor air intake shutters. In those years most aircraft were operated from unpaved airfields. Hence the carburettor air intakes mounted on the upper covers of the engine cowlings were fitted with dust filters. A shutter in the air duct sent the air stream into the engine either through the filter or past it. When the landing gear was down, the air was routed only through the dust filter. At take-off simultaneously with landing gear retraction the shutter turned, permitting unimpeded passage of the air stream and closing the passage through the filter.

Ilyushin Aviation Complex

Above: This heavily retouched photo shows an interesting queue of 16 early-production IL-12s (note the forward nose gear door segment) lined up for take-off – probably for the 1947 May Day parade in Moscow.

Yefim Gordon archive

This view of an IL-12B at Kiev-Zhulyany on 7th November 1954 illustrates the closed carburettor air scoops on top of the engine nacelles directing the air through the filters. Note the Soviet flag on the tail.



Via Polygon Press

Four views of a production IL-12B. Note the mildly gull-shaped wings in front view.

However, this arrangement proved to be of little use on the IL-12. Take-off from paved runways was performed with the air passing through the filter, entailing a loss of power at the most critical stage of the flight, and in Central Asia, where the wind sometimes raises dust clouds to altitudes of more than 2,000 m, the air came into the engine in cruise flight past the filter, thus causing excessive wear of the engine parts. When control of the carburettor air intake shutters was transferred to the flightdeck and was made independent of the landing gear position, available power during take-off from paved runways was increased by nearly 5%.

Some other new design features contributed to improving the IL-12's field performance. Flight tests revealed that extended undercarriage and flaps more than doubled the aircraft's drag as compared to the 'clean' (cruise flight) configuration. A good deal of this increment proved to be caused by the drag of wheels, struts and open undercarriage bays.

The first production IL-12s were fitted with a hydraulic system which retracted the undercarriage in 40-50 seconds; with one engine inoperative the retraction time increased to 60-70 seconds. The use of a new, more powerful hydraulic system made it possible to drastically reduce the retraction time to 10-11 sec. Concurrently the wheel well door control system was redesigned so that the doors opened only when the undercarriage was in transit. Keeping the wheel wells closed not only reduced the drag during flight with the undercarriage extended; at unpaved airfields the dust, mud and slush no longer entered the wheel wells and the mechanisms accommodated in them became more reliable. (In reality this feature did not find its way to the production lines until the advent of the IL-14).

Naturally, much attention was given to perfecting the engines and propellers and increasing their reliability during take-off. When the IL-12 began scheduled services, the ASh-82FN engines had a service life of 100-150 hours. This was sufficient for combat aircraft, but far from satisfactory for commercial ones. The OKB-478 engine design bureau led by Arkadiy D. Shvetsov succeeded in raising the service life of the engines to 300 hours.

Early production IL-12s were fitted with the AV-9Ye variable-pitch propellers which used the so-called reverse layout. In this arrangement the rotating blades were set at a coarse pitch by oil pressure and were set at a fine pitch by the centrifugal force. While mechanically simple, in the event of a feathering system failure such propellers spontaneously switched to fine pitch, which led to their overspeeding. The propeller's thrust fell drastically and a danger arose of the propeller and the engine disintegrating. For this reason this propeller was replaced in operation by the AV-9V propeller featuring the so-called direct layout in which the blade of a rotating propeller is set at a fine pitch by oil pressure and at a coarse pitch by the centrifugal force with the help of special counterbalances. The new propellers made it possible to retain the propeller thrust even if the featuring system failed, thus enhancing flight safety.

In the course of operation of the hot-air anti-icer in which exhaust gases were used directly for heating the wing leading edge, there were cases when the wing skin and the steel duct distributing the gas/air mixture in the spanwise direction suffered damage due to corrosion. This allowed the exhaust gases to come into contact with the primary structural members which also began to corrode. Thus, a direct threat to flight safety arose.

As a matter of urgency, a new hot-air anti-icer system for the IL-12 was developed; it made use only of the ambient air heated by exhaust gases in special heat exchangers. A major drawback of the system was the large size of the heat exchangers which protruded into the slipstream, reducing the cruising speed. On the credit side, the new hot-air anti-icer was reliable and did not endanger airframe integrity. From 1948 onwards this anti-icing system for the wings and a new, more reliable anti-icing system for the stabiliser leading edges were installed in production IL-12s.

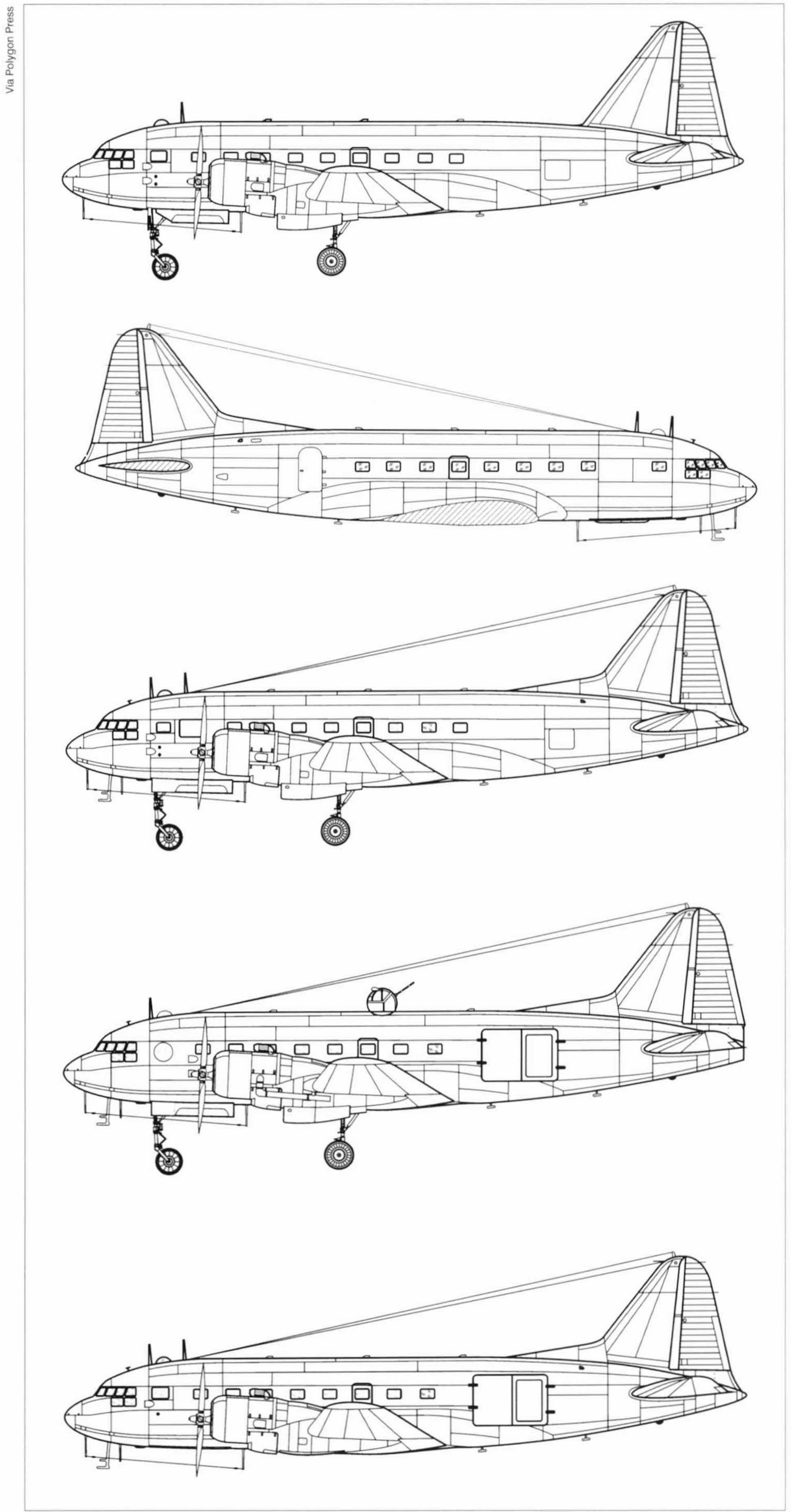
In this way, from batch to batch, improvements prompted by operational experience were introduced into the aircraft's design; the cumulative effect of these improvements was a qualitatively new level of flight safety. This was a factor contributing to the IL-12's long service career. In some units of the Civil Air Fleet and the Air Force these aircraft served on until the late 1960s.

IL-12-32 airliner

This was an aircraft for short-haul routes. The passenger cabin had a seating arrangement for 32 passengers (eight rows four-abreast, 2+2) and 600 kg (1,320 lb) of luggage. The cabin featured a coat closet, a toilet and a galley; a baggage compartment was located in the aft part of the cabin.

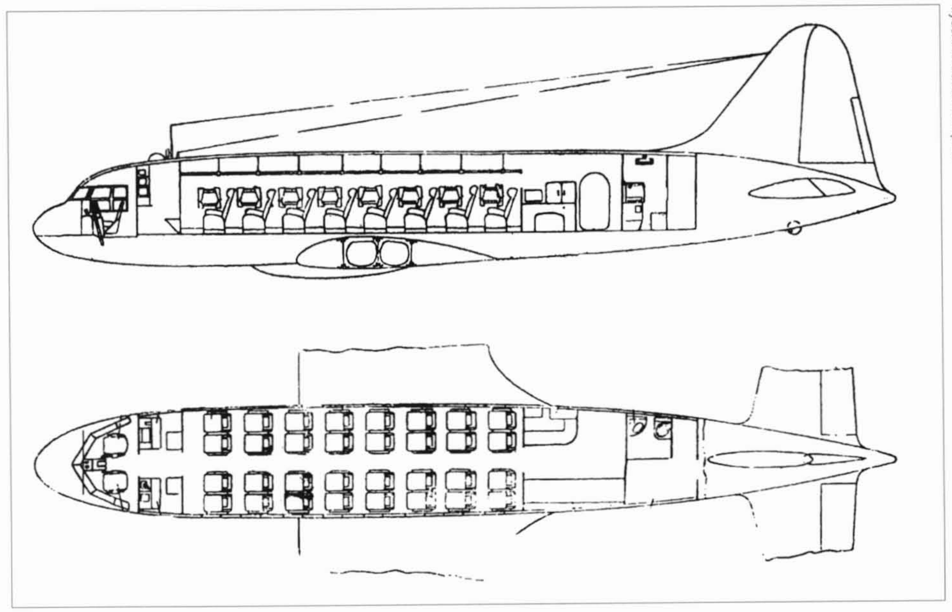
IL-12-16 airliner

The passenger cabin of this aircraft accommodated 16 sleeping berths. The upper berths were folding, like those of a sleeping car. The seats could be easily transformed into a lower berth. The cabin also accommodated two toilets, a coat closet and a rear baggage compartment for 500 kg (1,100 lb) of baggage.



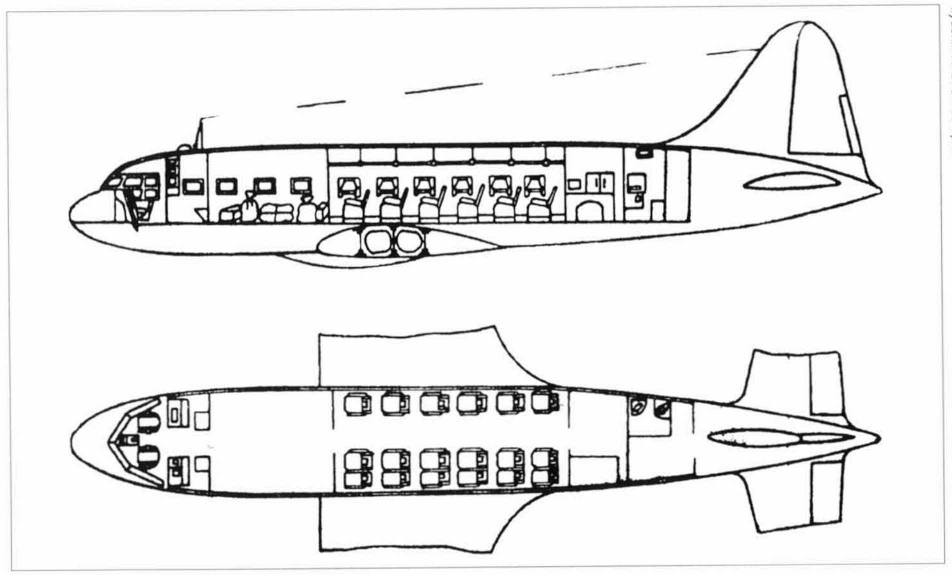
Via Polygon Press

Top to bottom: IL-12 *sans suffixe*, IL-12B, IL-12-21, IL-12-30D transport/troopship, IL-12T transport.



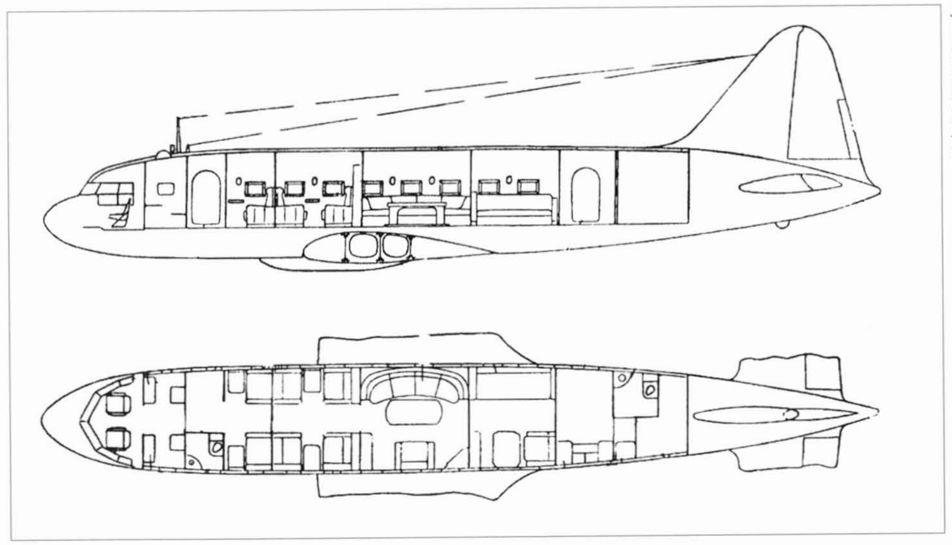
Ilyushin Aviation Complex

Above: The interior layout of the 32-seat IL-12-32.



Ilyushin Aviation Complex

Above: The interior layout of the IL-12-18 combi aircraft.



Ilyushin Aviation Complex

The interior layout of the IL-12-6 VIP aircraft; note the conference room amidships.

IL-12-11 VIP aircraft

The IL-12 had several VIP versions, one of which was designated IL-12-11 to reflect the number of seats. No more than ten aircraft were manufactured in this configuration. They had a greater fuel capacity and, accordingly, an increased range which reached 4,000 km (2,486 miles).

IL-12-6 VIP aircraft

A total of four machines were manufactured in this special-purpose variant. The aircraft had two entry doors and a passenger cabin divided into several compartments. The forward compartment was intended for the servicing personnel and the bodyguards. Further aft was a sleeping compartment with two sleeping berths which could be transformed into four seats. Placed in the middle of the cabin was a conference room outfitted with an upholstered leather sofa, a table and an armchair. Aft of it was the compartment for the VIP (the so-called 'chief passenger') with an upholstered sofa, a table for meals and an armchair. Adjoining it was a buffet-bar (!). Two toilets were placed fore and aft of the passenger compartments. One such aircraft was placed at the personal disposal of the infamous Minister of the Interior Lavrentiy P. Beria.

IL-12B airliner

An improved version for scheduled passenger services was designated IL-12B. Production began in 1948. In addition to a dorsal fin and the rudder with a spring tab it featured a new hot-air anti-icing system in which only the ambient air was used for heating the wing leading edge; the ambient air was heated by exhaust gases in special heat exchangers. This aircraft became the main export version.

IL-12B (Polar Aviation version)

The IL-12B was also used by the Soviet Polar Aviation in an extended-range configuration with extra fuel tanks. Initial production IL-12s *sans suffixe* were also used in this branch. An example registered CCCP-H440 (that is, SSSR-N440) having no dorsal fin and externally identical to early passenger variants with nine windows on each side was used for Antarctic research. (Curiously, there is also photoproof of an IL-12D bearing the same designation!) Presumably these were passenger aircraft converted for transport tasks by removing the passenger seats and installing some additional equipment for cold climate operations (such as self-contained heaters).

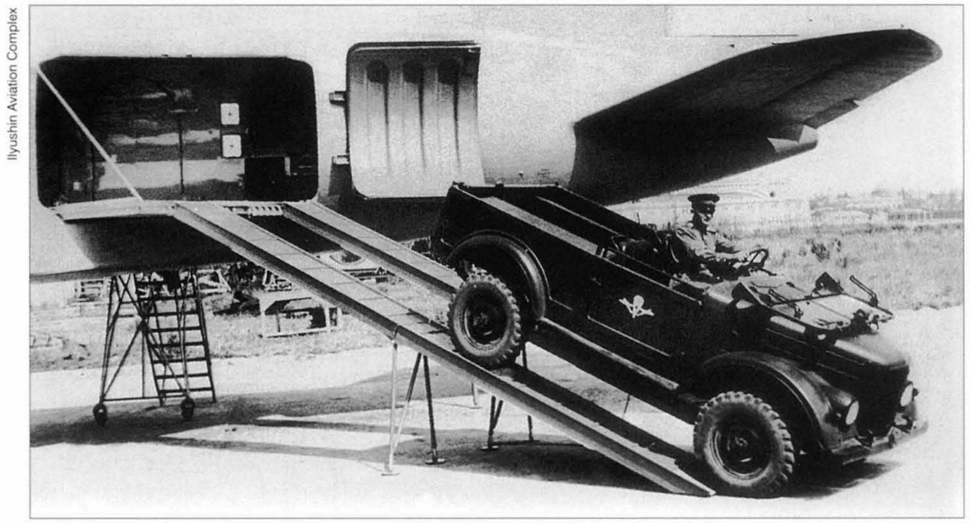
IL-12B (VIP version)

Two IL-12Bs were converted into VIP aircraft for 10 passengers.

IL-12T transport aircraft

Starting on 30th July 1947 the IL-12 passed State acceptance trials at GK NII VVS as well. To this end two standard IL-12s (c/ns 30034 and 30064, that is, plant No.30, the 4th aircraft in batches 03 and 06 respectively) were converted into the prototypes of a cargo version fitted with large double doors aft of the port wing. IL-12 c/n 30034 was intended primarily for towing Tsybin Ts-25 assault gliders, while the other aircraft was intended for carrying assault troops and cargo inside the fuselage. This machine was also used for developing the armament, for which purpose it was fitted with bomb racks under the wing centre section. On the whole the aircraft received a positive appraisal; yet, a whole series of deficiencies was also revealed. These included poor directional stability at low speeds, the lack of an adequately equipped workstation for the navigator, too cramped accommodation of the assault troops. These and other critical remarks were duly taken into account by the OKB when developing subsequent versions of the IL-12, including dedicated assault transport versions.

A dedicated transport version which entered series production in 1947 was allocated the designation IL-12T (***trahns****-portnyy* – transport, used attributively). It differed from the baseline passenger version in having a modified fuselage which had a double door measuring 2.4 x 1.6 m (7 ft 10½ in x 5 ft 3 in) on the port side. The rear portion of the double door incorporated a smaller door measuring 0.9 x 1.4 m (2 ft 11½ in x 4 ft 7⅛ in) which, like the usual entry door on starboard side, opened inwards. The cargo hold was provided with winches and was fitted with folding seats along both sides. The IL-12T could carry a cargo weighing up to 3,000 kg (6,615 lb). The aircraft was manufactured in series between 1947 and 1949 and was used for many years on domestic air routes, in Polar Aviation and in the Air Force.



Ilyushin Aviation Complex

Above: A GAZ-69 jeep with the Soviet airborne troops badge on the doors is backed into the cabin of an IL-12T transport, using special folding ramps. Note the wide troop entry door to starboard.

Below: This Soviet Air Force IL-12T coded '32 Red' was the personal 'hack' of the Volga Defence District Commander. It features an unusual two-tone red star on the tail and a 'lightning bolt' cheatline. Note that the rear segment of the cargo door incorporates a passenger door.

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IL-12D assault transport aircraft

The assault transport aircraft was manufactured in 1948 and was a further development of the IL-12T. It differed from its predecessor in having an enlarged entry door on the starboard side, measuring 0.9 x 1.6 m (2 ft 11½ in x 5 ft 3 in). Availability of two doors made it possible to effect the paradropping of troops in two flows. Two hatches measuring 0.8 x 2.1 m (2 ft 7½ in x 6 ft 10⅝ in) were provided in the floor of the centre part of the cargo hold fore and aft of the wing centre section. They were used for dropping cargoes which were attached to the shackles of cassette-type racks. On the outside, under the wing centre section, there were three beam-type racks for carrying large external stores; these design features made it possible to use the aircraft as an auxiliary bomber (in the unlikely event there weren't any

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A line-up of blue-coded Soviet Air Force IL-12Ds at a snowbound airfield. Note the large observation/aiming blister at the navigator's station characteristic of this version.

Sergey and Dmitriy Komissarov archive

ITAR-TASS

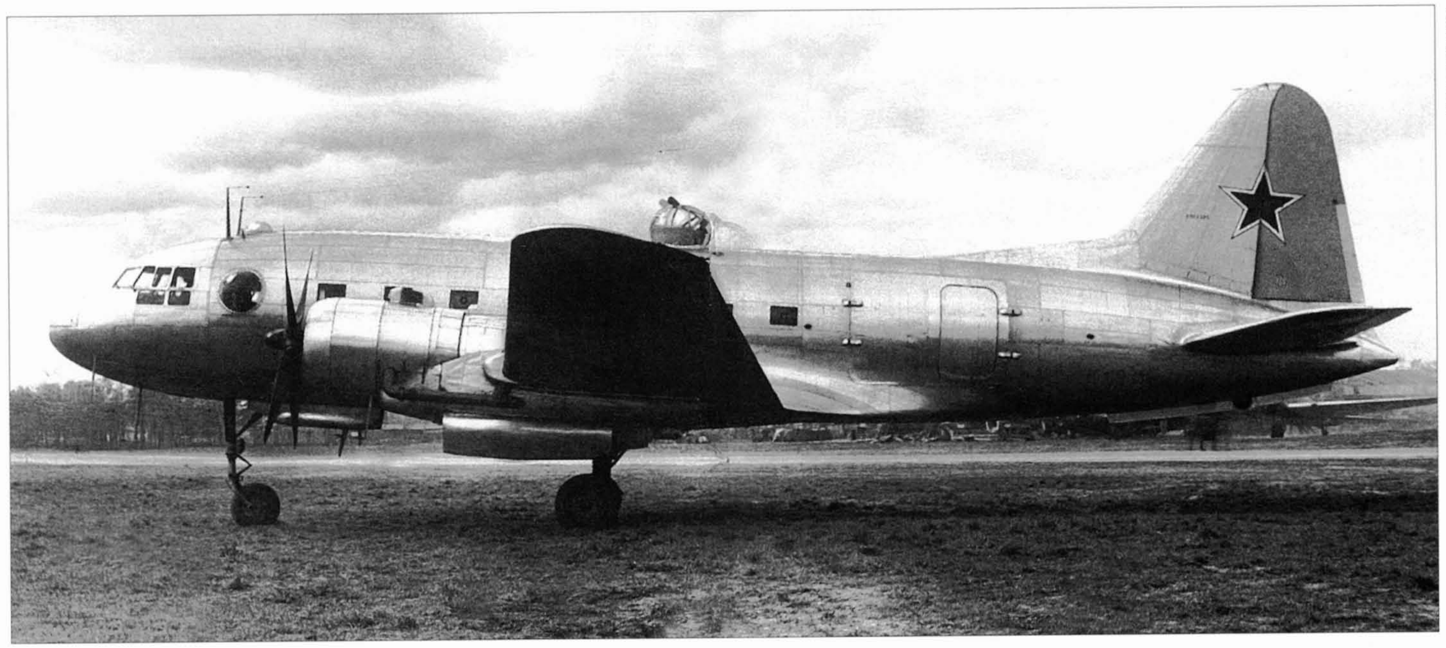
proper bombers left). Mounted on top of the fuselage was a glazed 'ball turret' with a ShKAS machine-gun (later replaced by a UBT machine gun). The large majority of the IL-12Ds did not have this turret, however, and the aperture for it was used for installing an astrodome. A window on the port side near the navigator's station was replaced by an observation blister which accommodated an OPB-1 optical bomb sight.

The IL-12D was manufactured in series in 1948-49. It was envisaged that the machine would lend itself to easy transformation into one of four basic configurations. In the transport version the aircraft was intended for the carriage of various military cargoes (including light artillery pieces, cars and the like) with a total weight of up to 3,700 kg (8,160 lb). A special folding ramp was designed for loading wheeled vehicles. In the assault version the aircraft could carry and drop up to 38 paratroopers who were accommodated in the cargo hold on folding seats. In the medevac configuration it could accommodate 27 stretcher cases and a medical attendant. The stretchers were placed in the cabin in three tiers. The fourth version was intended for towing medium-sized assault gliders (the Yak-14 and Ts-25).

Top: IL-12B CCCP-Л1704 has a non-standard livery with a 'lightning bolt' cheatline, huge Aeroflot titles and a large 'flying' flag.

Centre: Goods for the 9th Soviet Antarctic Expedition are unloaded from a ski-equipped IL-12D at Ice Station Vostok in June 1964. Note the rear paradropping hatch and the double set of radio altimeter aerials. Unusually, the aircraft (CCCP-01807) belongs to a regular Civil Aviation Directorate, not to Polar Aviation.

Below: This uncoded late-production IL-12D (c/n 8302325) features a dorsal fin and a 'ball turret' with a ShKAS machine-gun for self-defence. This turret was rarely fitted to operational aircraft.



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For this purpose a special lock for the towing cable was fitted instead of the fuselage tailcone; it was controlled through a cable linkage from the flightdeck.

IL-12D with a ski undercarriage

A few IL-12Ds transferred to Polar Aviation were fitted with skis. In 1959 an example registered CCCP-H561 (SSSR-N561) was equipped with skis by the specialists of the air transport detachment of a Soviet Antarctic expedition; it catered for the needs of a group of researchers who undertook a trip on tractor-towed sledges from Ice Station Komsomol'skaya into the heart of the Antarctic continent. Another ski-equipped IL-12D registered CCCP-01807 was used for delivering supplies to Soviet Antarctic stations in 1964.

Test and research versions

At least three IL-12 (identities unknown) were used for research and test purposes. One of them was a weather research aircraft, another (an Air Force IL-12T) was used for developing advanced anti-icing systems. A third aircraft was fitted out for aeromagnetic survey used in geological prospecting.

IL-12 – aerial photography version

Several IL-12 aircraft were modified for aerial photography duties, featuring a ventral camera port.

IL-12 – upgraded version

In 1956 about fifty IL-12s had their interiors upgraded to IL-14 standard.

IL-12 in action

As noted earlier, on 1st May 1947 the IL-12 had its public debut when pilots from Aeroflot's Vnukovo United Air Detachment flew their aircraft in formation over Moscow's Red Square during the May Day parade. In June 1947 the IL-12 was put on Aeroflot's scheduled passenger services, and by the end of the year these machines were operated by many territorial directorates of the Civil Air Fleet. During this time they logged a total of nearly 4,000,000 km (2,486,000 miles) and made more than 5,000 landings, having carried more than 120,000 passengers. These operations were economically very efficient. For example, the cost per tonne-kilometre proved to be less than half of the figure obtained on the Li-2.

However, the IL-12 had only been in airline service withe the Vnukovo UAD for a couple of months when an incident occurred. It revealed a deficiency which became the aircraft's veritable Achilles' heel. Many airport workers kept this day in their memory for a long time – their children could have died on that day! The local administration decided to send 43 schoolchildren to Adler, a summer resort on the Black Sea, on a new aircraft which had logged just a few dozen hours. The crew was captained by V. Chernyakov, one of the most experienced pilots. He entered the aircraft and cheerfully greeted his young passengers. What happened later was something he could only have seen in a nightmare. During the take-off run, when the speed reached 110 km/h (68 mph) and he was about to rotate the aircraft for take-off, the port engine cut. Chernyakov found it too risky to continue the take-off; he did all he could to effect an emergency braking. No tragic consequences ensued: the tricycle undercarriage prevented the IL-12 from nosing over, and the long runway of the capital city's airport permitted the aircraft to avoid an overrun and the resulting damage.

This incident prompted additional tests intended to develop piloting techniques for situations when the aircraft suffered an engine failure during take-off. A team from GosNII GVF headed by Ivan P. Mazuruk took the matter in hand. To conduct the testing, a large natural flat area covered with sun-baked clay was selected in the vicinity of Ashkhabad, the capital of the Turkmen SSR; the size of this flat area permitted to perform such flights with a minimum of risk. Preparation of the test programme was undertaken by M. V. Rosenblatt, the Institute's leading specialist in test methods. During the first flight the crew consisted of only three persons: Rosenblatt, Mazuruk and Il'chenko, the flight engineer. They decided to act in accordance with the IL-12's flight manual. As planned, during the take-off, just as the pilot pulled the control column for rotation, the

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Above: This early-production IL-12T was a de-icing systems testbed. Note the lattice-like sensor mounting brackets on the flightdeck sides and roof.

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A Polar Aviation IL-12 with appropriate titles and nose art shares an airfield with other IL-12s and Li-2s; one of the latter is registered CCCP-H393 (ie, SSSR-N393).

Boris Vdovenko

Above: A late-production IL-12 *sans suffixe* (note the full-length nose gear doors) registered CCCP-Л3925 is seen during a turnaround at Moscow/Vnukovo-1 in 1958, with IL-12Bs and IL-14Ps in the background.

flight engineer shut down the port engine; he then started the feathering procedure with a five-second delay because he had calculated that precisely this time was needed by the crew to take any decision in the case of an emergency suddenly arising. During these seconds the situation became nearly catastrophic. Immediately after the engine shut down Mazuruk briskly pushed the throttle of the functioning engine to the 'boost' setting. The aircraft which had just lifted off began to turn speedily to port while banking in the same direction. The pilot made superhuman exertions in order to keep the airliner on a steady course, but the aircraft was unwilling to continue the take-off and even brushed the surface of the airstrip with one of the undercarriage struts. Despite the vast dimensions of the improvised airfield, it was not boundless and the crew had no choice but to restart the port engine.

In the end the experimenters succeeded in evolving the test methods. They boiled down to the recommendation to push the throttle of the functioning engine to a boost setting gently, so that the emergence of the yaw would not be abrupt and the pilot would be able to cope with it. But the authors of this piloting technique still were very much in doubt about its efficiency; after all, it required a lot of nerve to be able to act 'gently' in an extreme situation!

In 1948 the IL-12 was introduced on Aeroflot's international services. The first such route to be flown was the Moscow-Sofia route operated by the joint Soviet-Bulgarian TABSO airline. The aircraft were staffed with mixed Soviet-Bulgarian crews, but the captain was always an Aeroflot pilot. In addition to Sofia, the IL-12s began scheduled flights to Berlin, Belgrade, Budapest, Warsaw, Vienna, Kabul, Prague, Teheran, Stockholm, Helsinki, Ulaanbaator and Hami (Western China). On 2nd August 1954 a flight performed by an IL-12 (captain V. K. Zamula) inaugurated a passenger service between Moscow and Paris.

On the whole the aircraft was well liked by its crews. It was far superior to the Li-2 as regards speed, range and comfort level. But the IL-12 was handicapped by its engines. Their TBO initially was no more than 100 to 150 hours, but this service life was barely enough for four to six weeks of Aeroflot operations, and sometimes the ASh-82FN engines had to be overhauled earlier than the nominal TBO. In the Aeroflot directorates of the central regions the problem was solved by changing the engines more often, but in the outlying directorates obtaining 'extra' replacement engines was no more than a pipe dream. For this reason in the initial period of their operation brand-new IL-12 sometimes stood idle while the modest Li-2 veterans went on flying.

Much effort was spent on bringing the engine up to the 'peacetime' standards. Its TBO was increased first to 300 hours and then to a still greater figure, but the level of real reliability was reached only in the ASh-82T version which made its appearance with the advent of the IL-14. When this aircraft began to enter the Aeroflot inventory, followed later by gas turbine-powered airliners, the IL-12 was gradually relegated to regional air services. This was accompanied by increasing as much as possible the number of passengers on board so as to achieve greater economic efficiency. In some Soviet civil aviation enterprises the humble IL-12s were operated up to 1970.

In addition to service on Aeroflot routes, the IL-12 was actively used in the Arctic and Antarctic regions. Here are just a few of the most vivid episodes from this part of the aircraft's biography. A unique operation conducted under the guidance of A. Girko took place in March and April 1950. Two IL-12Ds piloted by crews captained by A. Kharitoshkin and V. Rodin towed two Ts-25 cargo gliders from Chkalovskaya airbase (Moscow Region) to the North Pole; this was the first time that a landing operation of this kind was effected on the planet's top. Then the transports landed on an ice airstrip, took the gliders in tow again and delivered them to Krasnoyarsk. On 24th October 1958 an IL-12 registered CCCP-H440 with a crew captained by V. M. Petrov flew over the South Pole for the first time. But not only this made the event unique. The 7,000-km (4,350-mile) Mirnyy-South Pole-McMurdo-Mirnyy route (in this case Mirnyy is the name of a Soviet Antarctic research station, not the city in Yakutia) was covered with just one intermediate landing. To achieve this, the aircraft was crammed with 200-litre (55 US gal) fuel drums loaded into the cargo hold.

Wojskowa Agencja Fotograficzna

An interesting picture showing a pair of Polish Air Force IL-12s in company with an IL-14 (foreground), the type which succeeded them.

Deliveries of the IL-12 to the Soviet Air force started in 1948. The first service pilots took conversion training to the IL-12 at OKB-240 and at the production plant (MMZ No.30), the test pilots Vladimir and Konstantin Kokkinaki acting as instructors. The younger Konstantin Kokkinaki was especially active in this respect. After completion of conversion training the military pilots began ferrying the brand-new IL-12Ds from the Central airfield in Moscow to the 3rd and the 6th Air Divisions of the Transport & Assault Aviation (TDA – ***Trahns**portno-de**sahnt**naya avi**ah**tsiya*) based respectively in Vitebsk, Belorussia, and Krivoy Rog, the Ukraine. At that time the Transport & Assault Aviation was part of the Airborne Troops (VDV – *Voz**doosh**no-de**sahnt**nyye voy**ska***); precisely in 1948 it received a substantial reinforcement in the shape of several Military Airlift Regiments transferred from the Air Force. This situation lasted until 1955 when Military Transport Aviation was formed within the framework of the Air Force. Somewhat later the new IL-12D aircraft were delivered to the 12th Air Division based at Tula and an Air Division based at Pskov-Kresty AB, as well as to other Air Regiments and Air Divisions based all over the Soviet Union.

The statutory strength of each regiment comprised 32 machines: ten aircraft in each of the three squadrons and two in the command flight. The conversion from the Li-2 to the IL-12 posed no problems for the vast majority of the crews, although the new aircraft was more complicated than its predecessor. Combat training was conducted with great intensity. The airmen continued to perfect the tactical methods that had been practised on the Li-2, including flights in close formations which were considered to be among the most important elements required for successful paradropping of troops *en masse*. Equally great importance was attached to the scramble procedure and to the assembly of aircraft formations in the air. The aircraft took off at minimum intervals, which made it possible to assemble the regiment 'on the circuit' in the airfield area within 30 minutes. The introduction of the IL-12 into Air Force service coincided with the introduction of the OSP-48 instrument landing system. Therefore, as soon as the aircraft and the airfields were equipped with appropriate devices, the regiments started actively practising flights at night and in adverse weather conditions.

Adhering to the tradition of the first post-war years, the 363rd Air Regiment from Krivoy Rog continued to take part in the annual Tushino air displays between 1949 and 1954, now flying IL-12s. But, whereas the IL-12 produced a very good impression during the air displays, it fell short of fulfilling completely the increased needs of the Armed Forces. As a rule, not more than 20 paratroopers were taken on board. The aircraft was also used for transporting various supplies and light artillery pieces; the latter were delivered to their destinations exclusively by disembarking from the aircraft after landing, the side cargo door rendering paradropping impossible. An IL-12 carrying a cargo of this kind could penetrate to a distance of 600-700 km (373-435 miles) into the rear of the potential adversary and return to base. But one may well imagine the huge number of aircraft needed to land just one division of Airborne Troops in Western Europe! Moreover, the military wanted to transport by air not only troops and artillery, but light armoured vehicles as well, while the most that the IL-12 could handle was the diminutive SAU-57 self-propelled gun. In addition, in military service the unreliable engines likewise marred the reputation of an aircraft that was deemed fairly good on the whole. In the Transport & Assault Aviation this deficiency was not felt quite so acutely as in Aeroflot (the military IL-12s logged far fewer hours than their civil counterparts); yet, incidents and even crashes caused by engine failures did occur in the Army. For example, in the early 1950s a crew from the

RART

Above: China was one of the IL-12's foreign operators. Here a weathered but still active People's Liberation Army Air Force example serialled 35243 is seen somewhere in China in 1988.

Sergey and Dmitriy Komissarov archive

IL-12B OK-CBA (c/n 83012904 – ie, year of manufacture 1948, MMZ No.30, version 1, Batch 29, 4th aircraft in the batch) was delivered to ČSA Czechoslovak Airlines on 17th June 1949 and retired on 3rd January 1959.

Yefim Gordon

This IL-12T coded '10 Red' (c/n 30218) was preserved at the Soviet (now Russian) Air Force Museum in Monino south of Moscow.

Tula-based regiment captained by Major G. Miroyevskiy were killed in a crash after an engine failure on take-off; the same happened with the crew captained by Major V. Bordyugov from the 25th Air Regiment based in Kirovograd, the Ukraine.

Fairly soon the industry was in a position to offer more advanced aircraft, and the service career of the IL-12D and IL-12T in the Transport & Assault Aviation and its successor, the Military Transport Aviation (VTA – *Voy**e**nno-tr**ah**nsportnaya avi**ah**tsiya*) was fairly brief. When in 1956 the need arose to transport troops to Hungary to quell the anti-Communist uprising, only a very small number of IL-12s still remained on strength. According to available information, these aircraft were operated only by one regiment of the Tula-based Air Division.

The service history of the IL-12 includes one more sombre page. An unarmed aircraft with 21 passengers on board became the first victim of wanton aerial piracy. On the last day of the Korean War, 27th June 1953, an IL-12 performing a flight 300 km (186 miles) north of the border between North Korea and China was attacked and shot down by a USAF North American F-86G Sabre jet fighter which had violated China's airspace. Its pilot could clearly see that he was attacking a defenceless passenger aircraft.

On 24th April 1948 the IL-12 was demonstrated in Poland at the Poznan Trade Fair. This was the first time the IL-12 was shown outside the USSR. The aircraft registered CCCP-Л1701 (SSSR-L1701) was demonstrated statically and in flight. On that occasion LOT Polish Airlines signed an order for five IL-12s with seating arrangements for 18 to 21 passengers. The first aircraft arrived at Warsaw-Okęcie airport on 17th July 1949. It was registered SP-LHB and was used initially for training the flight and ground crews. The other machines (SP-LHA, SP-LHD, SP-LHE, SP-LHC) were immediately put on domestic and international scheduled services. In 1951 the number of passenger seats was increased to 26; later, seating arrangements for 24 to 28 passengers were used.

LOT lost two IL-12s accidents. In 1950 SP-LHE suffered an engine fire in flight. The machine successfully performed an emergency landing and then stood idle for two years, awaiting repairs; eventually it was returned to the Soviet Union to the Znamya Truda plant. In 1952 SP-LHC suffered an accident at Warsaw-Okęcie and was declared a write-off. In the same year LOT leased one IL-12B from the Czechoslovak carrier ČSA and went on operating these aircraft until the end of 1957. Thereupon these machines were transferred to the Polish Air Force where they served as staff and cargo transports for another two years. In addition, the Polish Air Force had several IL-12Ds on strength. They were used for transportation of various cargoes, for glider towing, for landing and paradropping troops, and as staff machines. The aircraft were finally struck off charge in the late 1960s.

In September 1949 an IL-12-11 was delivered to Romania where it was placed at the disposal of the Central Committee of the Romanian Communist Party. Even its registration testified to its 'party allegiance': the aircraft was registered YR-PCC (PCC stands for 'the Party's Central Committee'). This machine was destined to be the sole IL-12 delivered to Romania. On 28th February 1957 the aircraft was transferred to TAROM Romanian Airlines, with which it flew until 1964 with the registration YR-ILX.

On 11th March 1949 the first two IL-12Bs ordered by the Czechoslovak flag carrier ČSA arrived at Prague-Ruzyne airport. The aircraft were registered OK-CBA and OK-CBF. Before the end of the year three more IL-12Bs (OK-DBB, OK-DBC, OK-DBD) arrived from the Soviet Union; 1950 saw the delivery of another two machines (OK-DBG, OK-DBN), followed in 1951 by the last three examples (OK-DBR, OK-DBU, OK-DBW). The aircraft were operated on domestic routes in a 32-seat layout and on international services, including the Moscow-Prague route, in a 21-seat layout.

In 1951 OK-CBF suffered damage at Prague-Ruzyne airport. The machine was repaired but was written off three years later. On 4th November 1956 the machine registered OK-DBF crashed near Zurich. After the acquisition of more modern airliners by the ČSA two IL-12Bs (OK-DBG and OK-DBU) were relegated to cargo transportation duties. One more machine (OK-DBW) was converted into a flight checker for checking the functioning of airfield navigation aids (instrument landing systems and air traffic control radars). This IL-12 remained active in Czechoslovakia's civil aviation far longer than its stablemates; it was written off in June 1960. The Czechoslovak Air Force received two IL-12Ds from the Soviet Union in 1954. The aircraft were used for towing Yak-14 assault gliders and for paradropping troops. In 1956 the assault gliders were withdrawn from use and the IL-12Ds were returned to the Soviet Union.

Initial deliveries of the IL-12 to China took place in the second half of 1949. A group of Soviet pilots headed by Colonel Mikolaïtis ferried 20 aircraft from Moscow to Changchung in a northern province of China. The route took them through Sverdlovsk, Novosibirsk, Irkutsk and Chita. There were further deliveries which became massive in the second half of the 1950s, when Aeroflot and the VVS began phasing out the IL-12. In China these aircraft were fitted with the locally produced version of the ASh-82 engine which made it possible to considerably enhance the machine's reliability. In China the IL-12 remained in operation for a longer period then elsewhere. A civil aircraft registered '504' was in service until 27th October 1985, sister ship '503' was retired on 6th October 1988, and two military examples serialled '35240 Red' and '35241 Red' were active until as late as October 1993 when they were preserved for posterity in the People's Liberation Army Air Force Museum at Datang Shan.

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The cabin of an IL-12-18, looking aft, with the lavatory doors at the far end and the entry door on the left.

The IL-12 in detail

The IL-12 was built in two baseline versions (passenger and cargo); the former version was intended for carrying 16-32 passengers and their baggage. The crew comprised two pilots, a navigator, a radio operator and a flight engineer. The airframe was of all-metal construction.

Fuselage: Beam-and-stringer stressed-skin structure with 48 frames, 51 stringers. Placed between frames 11 and 17 was the forward baggage compartment measuring 2.95 m in length, 2.6 m in width and 1.9 m in height (9 ft 8 in, 8 ft 6 in and 6 ft 3 in respectively). Aft of it was the passenger cabin which was 7.93 m (26 ft) long and 1.94 m (6 ft 4 in) high. The walls, ceiling and cabin partitions were lined with a special heat- and soundproofing material – vatin (a fleecy jersey fabric); the vatin was covered with linen impregnated with varnish and nitrodope. The floor consisted of two layers of plywood with a layer of thermal insulation in between (on cargo aircraft the floor was made of duralumin).

The cabin featured rectangular windows whose number varied, depending on the version. The entry door was located on the starboard side of the rear fuselage; on passenger versions it opened outwards and forwards, on cargo versions, inwards and aft. Cargo versions had a double cargo door measuring 2,400 x 1650 mm (94½ x 65 in) located on the port side of the fuselage between frames 28 and 34; its rear half incorporated an additional door measuring 900 x 1,350 mm (35.4 x 53.15 in) which opened inwards. Emergency exits were provided above the wings; they were formed by hatches with windows which opened outwards and upwards.

Wings: Cantilever low-wing monoplane. The wings were a three-spar stressed-skin structure of trapezoidal planform built in three pieces: the extended-chord centre section (carrying the engine nacelles) and two detachable outer panels. Additionally, each outer wing panel had a detachable tip fairing. Dihedral 6°54' between the root rib and the inner/outer wing joint and 4° outboard of the engines; incidence 0°, camber 2° between the root ribs and the inner/outer wing joints. The wings were provided with slotted ailerons, simple hinged flaps on the wing centre section undersurface and flaps on the outer wing panels.

Tail unit: Conventional cantilever tail surfaces. The horizontal tail had 4° dihedral. The fabric-skinned rudder and elevators were aerodynamically balanced and mass balanced and incorporated trim tabs.

Landing gear: Hydraulically retractable tricycle type; the main units retracted forwards into the engine nacelles, the nose unit aft. The main units were fitted with twin 900 x 300 mm (35.4 x 11.8 in) brake wheels, the nose unit had a single 770 x 330 mm (30.3 x 13.0 in) non-braking wheel.

To protect the rear fuselage from damage in the event of a tailstrike, there was a tail bumper with a wheel measuring 300 x 125 mm (11.8 x 4.9 in). On the flightdeck there was a light indication of the position of the main undercarriage units.

Powerplant: Two Shvetsov ASh-82FN 14-cylinder two-row air-cooled radials with a take-off rating of 1,850 hp and a nominal rating of 1,630 hp at the rated altitude of 1,550 m (5,085 ft). The engines had direct fuel injection and were provided with two-speed superchargers and planetary reduction gearboxes.

The engines drove AV-9V four-bladed feathering propellers with a hydraulic pitch control mechanism. Feathering was controlled from the flightdeck.

Control system: Dual mechanical controls; the rudder pedals were also used for braking the wheels. A handwheel was provided for the elevator trim tab; the rudder trim tab was controlled by a switch and the starboard aileron's trim tab by a button; all of these, as well as the flap control valve, were placed on the central console. An autopilot was connected in parallel to the control circuit. To enhance reliability, the cable linkage to ailerons and elevators was duplicated.

Fuel system: The fuel (B-95/10 gasoline) was housed in ten tanks with a total capacity of 6,000 litres (1,320 Imp gal).

Electrical system: Primary DC power was provided by two 3-kW GSN-300 generators, with two 12A-30 storage batteries for backup.

Hydraulic and pneumatic systems: The primary hydraulic system was used for actuating the undercarriage and flaps, and for operating the brakes and the autopilot. It used MVP grade oil-type hydraulic fluid. In addition, there were emergency systems: a hydraulic system for the extension of main undercarriage units and a pneumatic system for the nosewheel leg, and a hydro-pneumatic system for the braking. A console with emergency system controls was placed in the radio-operator's compartment on the starboard side.

Anti-icing system: The aircraft was provided with a hot-air anti-icing system for the wing and the tailplane. Propellers were protected from icing with the help of an antifreeze solution or an alcohol-glycerine mixture. Flightdeck glazing panels were sprinkled with alcohol and cleaned with mechanical wipers; on the inside they were blown with hot air.

Heating system: The heating system ensured normal temperature conditions for passengers and crew and comprised two BO-10 gasoline heaters which were installed in the radio-operator's compartment. The amount of hot air fed into the flightdeck and the radio-operator's compartment was regulated by individual shutters. The warm air was distributed through the passenger cabin via two air ducts running along the cabin walls near the floor.

Ventilation system: The ventilation system was of the plenum-exhaust type. Fresh air supply came through two retractable air intakes in the forward fuselage and air ducts located under the baggage racks. The air was sucked out through three exhaust holes located in the negative pressure area on the upper side of the fuselage.

Fire suppression system: The fire suppression equipment comprised flame sensors, carbon dioxide bottles and spraying manifolds located in the engine nacelles, as well as control devices.

Avionics and equipment: The radio equipment comprised a communications radio with a wire aerial running from the flightdeck roof to the fin, a command radio, an ARK-5 radio compass, an RPK-1M direction finder, an RV-2 Kristall radio altimeter, a radio beacon receiver and intercom.

Specifications of the IL-12 airliner

	IL-12 prototype	**IL-12 production**	**IL-12 production**
Year of manufacture	1945	1947	1950
Engine type	ACh-31	ASh-82FN	ASh-82FN
Take-off power rating, hp	2 x 1,900	2 x 1,850	2 x 1,850
Wing area, m^2 (sq ft)	103 (1,109)	103 (1,109)	103 (1,109)
All-up weight, kg (lb)	16,000 (35,280)	17,500 (38,587)	16,100 (35,500)
Number of passengers	27	27-32	18
Payload, kg (lb)	2,900 (6,394)	2,040 (4,500)	1,740 (3,840)
Practical range, km (miles)	1,500 (932)	1,250 (777)	1,500 (932)
Cruising speed, km/h (mph)	325 (202)	344 (214)	330 (205)
at altitude, m (ft)	3,000 (9,840)	2,060 (6,760)	2,060 (6,760)
Take-off run, m (ft)	365 (1,200)	615 (2,020)	460 (1,510)
Landing run, m (ft)	450 (1,480)	700 (2,300)	600 (1,970)

IL-14 airliner with ASh-73 engines (project)

In late 1946, immediately after the completion of the IL-12's State acceptance trials, the staff of OKB-240 set about tackling a problem that was very complicated and quite new for the world aircraft industry at the time. It was the problem of ensuring a twin-engined aircraft's ability to perform a take-off immediately after the failure of one of the engines during the take-off run or immediately after the lift-off.

The need for this was dictated both by the results of the IL-12's flight tests and by operational experience with the huge fleet of twin-engined airliners which at that time consisted largely of DC-3s and Li-2s. The experience of their operation included numerous cases when, after an engine had cut, the crew was compelled to continue the take-off because aborting it was already practically impossible or much more dangerous than continuing the take-off.

The need for a passenger aircraft capable of securely completing the take-off after an engine failure became more and more acute as the volume of air transportation grew. However, a number of complex technical problems had to be solved if one wished to create such an airliner without sacrificing its profitability. The main problem was that the installation of more powerful engines had a negative effect on the aircraft's payload/weight ratio and its economic efficiency.

On 11th February 1947 Chief Designer of OKB-240 Sergey V. Ilyushin wrote to Head of GU GVF Air Marshal Fyodor A. Astakhov, asking him to consider a proposal envisaging the eventual introduction of the IL-14 airliner powered by two Shvetsov ASh-73 18-cylinder radial engines into service with Aeroflot. Ilyushin wrote, among other things: *'Following the path of perfecting our country's transport aviation, [...] the aircraft will be capable of confidently performing flights with one engine inoperative. [...] If we build the IL-14 we shall advance to the first place in the world in the class of twin-engined transport aircraft.'*

In its basic layout and aerodynamic and structural features the first variant of the IL-14 passenger aircraft closely followed the IL-12, differing from it only in having somewhat bigger dimensions and weights. The intention was to equip the IL-14 with two ASh-73 air-cooled radials which, with their take-off rating of 2,400 hp, were the most powerful Soviet aircraft engines of that period. The higher power/weight ratio enabled the aircraft to continue the take-off after an engine failure at a speed exceeding the stalling speed (when stopping the aircraft became impossible because of the limited runway length), while increasing the number of passengers to 48 made such a variant of the IL-14 closely comparable with the IL-12 in terms of economic efficiency.

The project of the IL-14 powered by two ASh-73 engines, endorsed by Ilyushin in the spring of 1947, failed to be implemented. The experience gained in this project led the designers to the conclusion that a mere increase of the available power did not ultimately solve the problem of continued take-off with one engine out. The availability of a considerable power reserve entailed serious difficulties with directional trimming after an engine failure during take-off: the emergence of a strong yaw required the fin, rudder and ailerons to be sufficiently effective at low flight speeds to counter the unwelcome deviation from the take-off path. At the same time the aircraft's handling had to remain simple, without undue increase of the control forces.

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Top and above: CCCP-Л1850, an early-production IL-14, in the same basic livery as applied to the IL-12. The marked forward sweep of the wing trailing edge, the redesigned tail and closed wheel wells are clearly visible.

IL-14 airliner prototype with ASh-82T engines

Research on the abovementioned problem was conducted within the framework of the programme for perfecting the design and enhancing the flight safety, performance and operational qualities of the IL-12 which by that time had become the main type on Aeroflot's trunk routes. The work was triggered by the Council of Ministers directives dated 9th October 1949 and 10th June 1950 which tasked OKB-240 with developing a version of the IL-12 with improved aerodynamics and engines that would guarantee flight safety at all flight stages.

The work was conducted jointly with GosNII GVF, TsAGI and LII. Design studies and results of the IL-12's flight tests led to the conclusion that the problem of continuing a take-off with one engine inoperative could be solved in the process of further modernising the aircraft by means of improving its aerodynamics, directional and lateral stability and controllability, coupled with a relatively modest increase of the take-off power of the production ASh-82FN engines. The aerodynamics of the IL-12 at take-off could be improved by fitting new wings, the work on which was conducted together with TsAGI, and by reducing the drag through a number of structural modifications.

The new wings had an identical span, but the area was reduced by 3 m^2 (32.3 sq ft) by deleting the forward extensions of the wing centre section leading edge between the fuselage and the engine nacelles. The thickness/chord ratio was increased, making it possible to accommodate all fuel tanks in the detachable outer wing panels, at a considerable distance from the passenger cabin, thus reducing the fire hazard. The thicker wings also helped improve the lifting properties and reduce structural weight.

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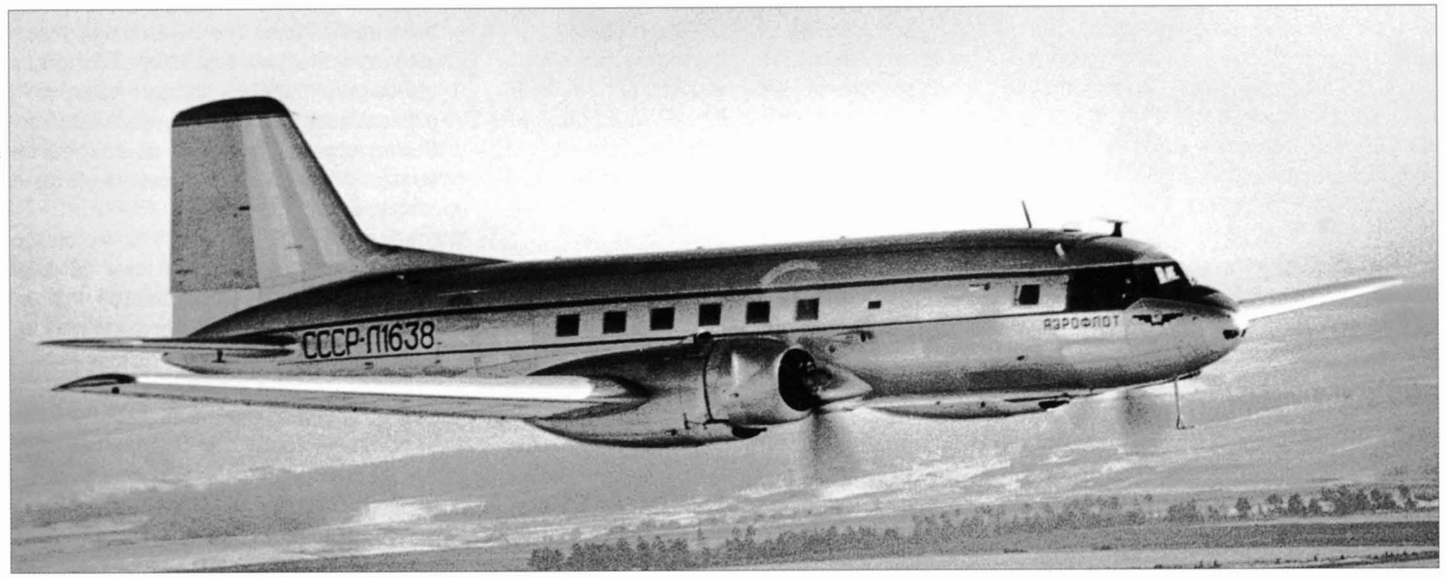

Above: CCCP-Л1638, a Moscow-built IL-14P (c/n 146001020 – ie, *izdeliye* (product)14, year of manufacture 1956, MMZ No.[3]0, Batch 010, 20th aircraft in the batch out of 50), cruises over the Russian countryside. The small window between the flightdeck and the six cabin windows is the galley window.

However, the main peculiarities of the IL-14's wings were in their aerodynamic configuration. The wing used the SR-5 airfoil section developed by Yakov M. Serebriyskiy and Maria V. Ryzhkova which was constant all along the span; this airfoil created considerably less drag compared to the IL-12's wing profile while possessing virtually the same lifting properties. To improve the flow separation characteristics and preclude the onset of flow separation on the extreme outer wings when executing low-speed manoeuvres, the new wings were given a forward sweep of 3° at quarter-chord. Thanks to this feature, part of the air flow speed was directed spanwise from the wingtips towards the fuselage; in consequence, the boundary layer at the wing roots became thicker and it was primarily in that zone that flow separation began. As a result, the high efficiency of the ailerons which was so important during a take-off with one engine inoperative was retained up to very high angles of attack.

The wings' high-lift devices were also subjected to modification. The IL-14 was provided with flaps only, and the lift/drag ratio of the wings with extended flaps in the speed range from unstick speed to 175 km/h (109 mph) – that is, at the most hazardous part of the continued take-off with one engine inoperative – became higher than that of the IL-12. This enabled the aircraft to use less time for reaching lift-off and for gaining speed and altitude.

The improvement in rate of climb was also facilitated by reducing the undercarriage retraction time to nearly a half of what was required by the IL-12. The harmful drag created by the dead engine's propeller was reduced by installing improved AV-50 propellers whose blades moved into fully feathered position within 4-5 seconds, that is, twice as quickly as the blades of the AV-9V propellers installed on the IL-12.

By reducing the drag at take-off, the new design features created the same effect as if the available engine power had been increased. Calculations showed that the new aircraft would be able to perform a secure single-engine take-off in all operation modes, provided that the power of the production ASh-82FN engines was increased by as little as 50 hp. Arkadiy D. Shvetsov's OKB-478 boosted the engine by increasing its rpm and supercharging ratio and improved the cooling of the cylinder heads. The take-off rating of the new engine, designated ASh-82T, was increased to 1,900 hp; it was retained up to the altitude of 400-500 m (1,310-1,640 ft), which markedly improved the safety of 'hot and high' operations of the new aircraft. The introduction of special adjustment and some additional design features helped reduce the fuel burn in cruise: at power ratings between 45 and 60% of the nominal power the fuel consumption per hour was 15% lower in comparison with the ASh-82FN. At the same time work was started on increasing the engine's reliability and bringing its service life to 500 hours. New engine nacelles were designed for the ASh-82T; their cowlings afforded easy and unobstructed access to all units and accessories.

The measures meant to improve the new aircraft's directional stability and controllability, which were crucial during a single-engine take-off, were initially limited to the installation of a spring tab on the rudder.

The new machine retained the basic features of the IL-12's passenger cabin in its 18-seat configuration. Yet, the operational CG range of the IL-14 had a considerably more forward location (12-19% MAC instead of 19-22% on the IL-12), which was due to placing some equipment items, the baggage compartment and a galley in the forward fuselage. In this connection, to preserve the longitudinal stability characteristics, the horizontal tail area of the IL-14 was enlarged by 6% by increasing the elevator area. The more forward CG position made the aircraft more stable on the ground (it tilted back-

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This early-production Soviet Air Force IL-14 sporting a lightning bolt cheatline but no tactical code is obviously a staff transport. Note the small star on the extreme nose.

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Above: IL-14P CCCP-Л1870 (c/n 146000401) taxying at a Soviet airport displays the long strake aerial on the starboard side characteristic of early-production examples.

wards only when the CG moved to 35% MAC or further aft) and made it possible to dispense with the supporting strut under the tail which was used on the IL-12 during ground operations.

In addition to measures designed to ensure continued take-off with one engine inoperative, much attention was paid to enhancing flight safety and the safety of landings in adverse weather conditions, including the perfecting of the anti-icing system and the installation of new flight/navigation and radio communication equipment. A special combined hot-air anti-icing and heating system was developed for the IL-14; its air/exhaust heat exchangers were accommodated in the lower parts of the engine nacelles and did not protrude into the slipstream. This entailed a slight increase in the engine nacelle cross-section, but aerodynamically this arrangement was more rational than the arrangement used on the IL-12. The heated air was used both for the anti-icing system of the wings, engine nacelles and tail surfaces, and for heating the flightdeck and the passenger cabin.

Flight safety and regularity of operations of the new aircraft in daytime and at night, in visual and and instrument meteorological conditions, was enhanced by additional equipment and radio devices, including an instrument landing system. Operational efficiency and ease of maintenance were achieved thanks to good access to inspection points and ease of dismantling that was characteristic of most units, including the engines. All piping and wiring was accommodated in special conduits with detachable covers; this made inspection and repairs more convenient, reducing the time needed for scheduled maintenance checks during intermediate stops.

The first prototype IL-14 incorporating the design improvements listed above had a hybrid airframe retaining the wings and vertical tail of the IL-12. It was built primarily for the purpose of bringing to light the special features of a single-engine take-off and of checking in flight the design features associated with the introduction of the ASh-82T engines, the more powerful hydraulic system, the improved wheel well door actuation mechanism and the combined hot-air anti-icing and heating system.

Defying superstition, test pilot Vladimir K. Kokkinaki took the prototype into the air for the first time on 13th July 1950. However, the omen worked; the flight had to be discontinued after the lapse of a mere 15 minutes because of the excessive temperature in the hot-air system's heat exchangers. To remedy this the hot-air piping was insulated with asbestos fabric, whereupon the test programme was completed without complications, although, in the opinion of the test pilots, the hot-air anti-icing system of the wings and tail unit was not powerful enough.

IL-14P airliner prototype

The second prototype IL-14 designated IL-14P (*passa**zheer**skiy* – passenger, used attributively) featured a new exhaust system and a new hot-air system which were combined in a single unit; they were designed on the basis of experience gained during the testing of the first IL-14 prototype. Each of the engine's two exhaust manifolds was connected with an exhaust pipe passing above the wing. The exhaust pipes were shrouded by heat exchangers, and the hot gas transmitted its heat through the pipe walls to the air that was fed through ram air intakes located in the engine nacelle lips. The exhaust system together with the heat exchangers and the piping for draining off excessive air was covered by a fairing extending all the way to the wing trailing edge. This design feature made it possible to improve the contours of the engine nacelles; the anti-icing system units no longer created much drag. The wings fitted with the new engine nacelle gave the new aircraft a lift/drag ratio of 19 instead of 16 on the IL-12 with its externally located ant-icer heat exchangers. The new design feature also eliminated the possibility of dangerous corrosion of the wing structure because the exhaust gases were discharged at the wing trailing edge and no longer could come into contact with the skin or penetrate inside the structure.

Tests of the first ('hybrid') IL-14 prototype revealed the necessity to improve directional stability and controllability at low speeds characteristic for take-off with one engine inoperative. Therefore the area of the vertical tail on the IL-14P was increased by 17% by means of altering the contours of the upper part of the fin and rudder; the vertical tail now had a trapezoidal shape instead of a quasi-triangular one. This gave the aircraft a considerable margin of static directional stability. As for the lateral stability at low speeds, the designers opted for a value which was close to neutral. This feature (that is, a combination of high directional stability and low lateral stability coupled with the ailerons that were efficient in all flight modes)and the availability of a spring tab on the rudder, were intended to ensure easier handling in the event of a sudden engine failure during take-off and in level flight with one engine inoperative.

Construction of the second prototype featuring the new wings, the reshaped vertical tail and the improved combined hot-air system was completed two and a half months after the commencement of the first IL-14 prototype's test programme. On 1st October 1950 a crew captained by Vladimir K. Kokkinaki performed the first flight on the IL-14P prototype. The new aircraft received a high appraisal; the pilots noted the spacious and well-lit flightdeck. The windshield and the side glazing panels had greater height than on the IL-12, affording a better view forwards and to the sides.

Thanks to the excellent directional stability and well-chosen aerodynamic balance of the rudder the aircraft could perform turns with up to 30° bank with the help of ailerons alone, without the use of the pedals. In this case the rudder was deflected to the required angle of its own accord.

At a full AUW the IL-14P confidently performed a take-off with one engine inoperative and the second engine at nominal power. It could perform sustained level flight on one engine (with the propeller of the inoperative engine feathered) with the undercarriage extended. The control forces in such a flight differed from normal ones so insignificantly that they did not call for the use of trim tabs. After a single-engine failure the aircraft gradually developed a tendency for turning into the direction of the dead engine which could easily be countered by deflecting the rudder.

Hazardous work on investigating the special features of a single-engine take-off and studying the IL-14P's controllability in critical flight modes was conducted by Vladimir K. Kokkinaki. Comprehensive tests of this kind were conducted for the first time in the USSR; beginning with this machine, they became an obligatory component of the flight test programmes of all Soviet multi-engined passenger aircraft. The results corroborated the effectiveness of all the basic design features incorporated into the IL-14P.

The manufacturer's tests also demonstrated that the hot-air anti-icing system of the wings and tail surfaces functioned efficiently in all engine operation modes, at normal flight speeds and single-engine flight speeds.

State acceptance trials of the IL-14P commenced on 2nd December 1951 and were completed on 23rd August (according to some sources, on 30th August) 1952. Lieutenant-Colonel A. S. Rychkov was appointed project test pilot; Colonels Yuriy A. Antipov, Mikhail A. Nyukhtikov, Ivan M. Dzyuba, Major E. V. Golenkin and Captain S. G. Dedukh also took part in the testing. They noted that the IL-14P was endowed with easier handling and landing techniques than the production IL-12; flying personnel would not have to be specially trained to convert to the new machine. On 13th August 1952, when the State acceptance trials were still in progress, service tests of the IL-14P started at GK NII VVS and in airline service in different regions of the country. The IL-14P proved to be a very reliable aircraft, simple to fly and maintain, capable of operating from small dirt airstrips and economically efficient. The IL-14P was 30 km/h (18.6 mph) faster than the IL-12; the range was also increased. The IL-14P's greater AUW (an increase of 400 kg/880 lb was due primarily to additional equipment and radios) did not affect the aircraft's rate of climb. The service tests were completed on 13th (again!) October 1952.

The greater area and altered shape of the vertical tail and the availability of a spring tab on the rudder led to a considerable improvement of lateral and directional stability and controllability. The pilots noted that in all modes of sustained sideslip with the rudder fully deflected the aircraft retained lateral and directional stability without any tendency to lose control. At low speeds (150-180 km/h; 93-112 mph) and extreme bank angles, flow separation was noted on the vertical tail; it manifested itself as a buffeting of the tail surfaces and slight shocks on the pedals from time to time. These phenomena served as a warning to the crew that the maximum admissible angle of rudder deflection had been attained.

Longitudinal stability and controllability were also improved. The elevator margin with the CG at its extreme forward position ensured a sufficiently simple landing. When reaching a stall mode the aircraft gradually lowered its nose, the ailerons remaining sufficiently effective.

On 22nd November 1952 the IL-14P was again submitted for checkout trials at GK NII VVS; these were completed on 30th December with a recommendation that the aircraft be put into large-scale production at MMZ No.30 in Moscow. However, on 1st April 1953 the Council of Ministers issued a directive ordering the IL-14P airliner into production at Plant No.84 in Tashkent which had built the Li-2 until then. The plant started IL-14 production in the autumn of 1953 as the first manufacturer of the type.

IL-14P production airliner

On 14th March 1954 the first production Tashkent-built IL-14P (c/n 4340101 – that is, year of manufacture 1954, plant No.84 (34 was a code used for security reasons), batch 01, 01st aircraft in the batch) performed its first flight. The crew comprised captain Vladimir K. Kokkinaki, co-pilot N. S. Gavritskiy, flight engineer M. F. Kuz'min, radio operator I. S. Siliminov and test engineer V. F. Voskresenskiy. From 1956 onwards the IL-14P was also manufactured MMZ No.30 ('Znamya Truda').

In 1954 production IL-14Ps passed additional service tests which were divided into two stages embracing the spring-summer and autumn-winter periods of operation. The aircraft were tested both in the extremely harsh conditions of Yakutia and the Krasnoyarsk Region, where the temperature at ground level could be as low as –55°C (–67°F), and in hot-and-high conditions. The service tests of an IL-14P registered CCCP-Л5063 (c/n 4340204, project test pilot A. I. Voskanov) was completed on 11th November 1954. The results of the testing corroborated that the designers had succeeded in creating a multi-purpose aircraft possessing enhanced operational safety, embodying advanced design and high reliability and meeting the most stringent domestic and foreign requirements.

The IL-14P started scheduled passenger services on 30th November 1954. During that period these aircraft were also widely used for government flights of special importance. In 1955, during the visits of a Soviet Government delegation to India, Burma and Afghanistan, ten IL-14Ps logged in all 22,500 km (13,984 miles) each. During all stages of the flight the hardware functioned faultlessly. The operation of these aircraft on Aeroflot's routes confirmed their high safety level, reliability and ease of maintenance.

The service career of the IL-14P started at the time when the temporary limitations imposed on the AUW of the IL-12 were still in force. Their were extended to cover the new aircraft, too. Therefore the IL-14P was initially operated in the 18-seat first-class configuration of the passenger cabin. However, the growing volume of passenger traffic dictated an increase in the seating capacity, and when the temporary limit on the AUW was lifted some aircraft were refitted to a 24-seat layout. After the increase in the number of passengers the CG position shifted aft; to retain the longitudinal stability and controllability characteristics, a feel spring was introduced into the elevator control circuit. The operational CG range was increased and could now be varied between 13 and 21% MAC. To retain the previous range, the AUW was increased to 17,000 kg (37,485 lb).

IL-14P-24 airliner

When the AUW limit was lifted some aircraft were converted into 24-seaters to meet the growing demand for air transportation. The seats were arranged in six four-abreast rows. To preserve the previous range, the all-up weight of the aircraft had to be increased to 17,000 kg (37,485 lb).

On 1st November 1955 an IL-14P configured with a 24-seat cabin (possibly registered CCCP-Л2040; c/n 4340506) entered flight test with V. K. Kokkinaki as project test pilot and D. N. Simanovich as project

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Above: An Aeroflot IL-14P takes off at Moscow-Sheremet'yevo. This example lacks the starboard side strake aerial.

Yefim Gordon archive

Above: Yugoslav Air Force IL-14M '7404' (formerly YU-ADG with JAT Jugoslovenski Aerotransport, c/n 147001317) taxies out for take-off. It was later reserialled 71404.

Yefim Gordon archive

Another Moscow-built IL-14M, an Albanian Air Force example serialled 15-09 (c/n 147001509).

engineer). After the successful completion of the tests this variant was built in series.

IL-14P-28 airliner

After the introduction of the turboprop-powered An-10 and IL-18 airliners on major air services the piston-engined IL-14s were relegated to local services and the number of seats in the cabins was increased to 28. This was achieved by reducing the seat pitch and by deleting the galley which was not needed on local routes.

IL-14P-32 airliner

In this case the increase in the seating capacity was achieved in the same way as in the previous version: by changing the seat pitch, deleting the galley and reducing the volume of the forward baggage compartment. In addition, some items of equipment were transferred to the radio-operator's and navigator's workstations, a radio equipment bay was deleted and additional seats were installed in its place.

IL-14PS VIP aircraft

This version was produced on the basis of the IL-14P (S stands for [*samo**lyot**-*] *sa**lon*** – VIP aircraft). The wings, tail unit and undercarriage remained unchanged. A new cabin was fitted and its underlying structure was reinforced. The electric wiring for the cabin lighting was changed and a call system activated by the *main passenger* with aural and visual indication was fitted. The passenger cabin was divided by a curtain into two parts; the sofas were arranged diagonally, opposing each other. Nikita S. Khrushchov travelled in this aircraft during his visits to Burma, India and Afghanistan.

The aircraft's empty weight was 12,500 kg (27,560 lb); the operational load was 715 kg (1,580 lb) and the payload 455 kg (1,003 lb), including 55 kg (120 lb) of baggage. The IL-14PS could carry 5-8 passengers.

IL-14S VIP aircraft

On 1st February 1955 the Soviet Council of Ministers issued an official resolution calling for the manufacture of 20 IL-14S aircraft for the Government flight detachment. However, the construction of a VIP aircraft featuring enhanced comfort had begun somewhat earlier, in 1954. On 28th August 1954 OKB-240 Chief Designer Sergey V. Ilyushin sent a letter to Minister of Defence Nikolay A. Bulganin, asking him to authorise service tests of ten IL-14S aircraft intended to be operated by the 2nd AKDON (*aviatsi**on**naya krasno-zna**myon**naya di**vee**ziya o**sob**ovo nazna-**chen**iya* – Red Banner Special Mission Air Division); Ilyushin expected that every aircraft from this batch should log no less than 500 hours so as to reveal and cure all eventual defects. In October manufacturing drawings and other documents were transferred to the production plant.

The IL-14S was based on the IL-14P and featured the following alterations. The wings remained unchanged; a partition was moved from fuselage frame 17 to frame 15. The emergency exits were transferred to a location between frames 22 and 23; additional windows were introduced on both sides between frames 16 and 17. The windows of the passenger cabin were fitted with 8 mm (0.31 in) thick bulletproof glazing panels. The underlying floor structure and the floor itself were reinforced, the navigator's workstation was fitted with additional items of equipment.

Changes in the electric system and radio equipment included the replacement of standard generators with GSR-6000A generators; centralised AC supply was introduced; more powerful lighting was installed in the passenger cabin. The RSB-D and RSB-5 radios were replaced by Dunai (Danube) radios; additionally, an RSIU-3 radio was installed. The ARK-5 automatic direction finder was equipped with four control panels, combined antennas were installed.

The aircraft was provided with oxygen equipment, pilots' and navigator's seats of improved design were installed. The passenger cabin was divided by a curtain into two compartments outfitted with special furniture; it comprised two sofas, two tables and four armchairs, with the sofas placed on one side of the cabin and the tables on the other side.

On 6th October 1956 GK NII VVS began flight testing of an IL-14S with specially modified exhaust pipes. The crew was captained by M. N. Dotsenko, with G. I. Filonenko as project engineer.

IL-14S aircraft were used by the Presidents of India and Guinea. The aircraft's empty weight was 12,800 kg (28,220 lb) and the operational load 715 kg (1,580 lb); the IL-14S could carry a 950-kg (2,140-lb) payload, including 6-8 passengers and 150 kg (330 lb) of baggage.

IL-14SI VIP aircraft

This aircraft was based on the IL-14P and differed in having increased range. In this connection the fuselage and wings were reinforced, additional fuel tanks were installed in the wings. The fuselage was reinforced in the same way as that of the IL-14S. The tail unit and the undercarriage remained unchanged.

The electrical system and the radio equipment system featured a new layout borrowed from the IL-14M aircraft. The RSB-D and RSB-5 radios were replaced by two Dunai radios and two RSIU-5 Doob (Oak) radios. The ARK-5 ADF was additionally fitted with two control panels and two indicators; combined antennas were installed.

There were also changes in the special equipment: seats for radio operator and navigator were installed, the pilots' seats were of an improved design. More efficient thermal insulation and soundproofing were introduced, the NI-50BM ground position indicator was installed. The aircraft was provided with oxygen equipment and a DGMK-5 gyromagnetic compass.

The cabin compartments divided by a curtain were outfitted with furniture of the same type as on the IL-14S, but the table in the forward compartment was deleted and replaced by an additional armchair. The aircraft's empty weight was 13,800 kg (30,490 lb) and the operational load 725 kg (1,600 lb); the 455-kg (1,000-lb) payload included five passengers and 55 kg (120 lb) of baggage.

IL-14SO VIP aircraft

This version was based on the IL-14SI, but the furniture of the latter which included sleeping berths was replaced by seats for 18 passengers. Hence the O may stand for *ob**slooga*** (service personnel), indicating that the aircraft was intended to support the head of state's trip abroad when a lot of service personnel had to be carried.

Structurally and with regard to special equipment the aircraft was similar to the IL-14SI. The aircraft's empty weight was 12,890 kg (28,420 lb) and the operational load 715 kg (1,580 lb); the 1,515-kg (3,340-lb) payload included 75 kg (165 lb) of baggage.

IL-14-30D transport/assault aircraft

On 14th November 1955 the Council of Ministers issued a directive ordering the development of the IL-14-30D version intended for the transportation of cargoes or 30 troops.

The transport and assault version was based on the IL-14P. The wings were modified for the installation of formation lights. The fuselage underwent some structural modifications: a large two-piece cargo door was installed aft of the port wing; unlike the IL-12T/D, the paratroop door was built into the forward half of the cargo door, not the rear one. The hatch for the forward baggage compartment was deleted. An observation/sighting blister was installed on the port side at the navigator's station, and a mounting ring for a dorsal turret was provided in line with the wing trailing edge (no turret was actually fitted). The partition at frame 17 was deleted, the cabin floor and the frames in the cabin area were reinforced. Instead of passenger seats the IL-14-30D featured folding seats along the cabin walls for 30 paratroopers. The aircraft was equipped with formation and identification lights.

The tail unit and the undercarriage remained unchanged. Changes in the special equipment included deletion of the individual ventilation and heating ducts; the heat- and soundproofing blankets in the troop cabin and in the toilet were deleted.

The empty weight was 11,800 kg (26,020 lb) and the operational load 640 kg (1,410 lb).

IL-14M production airliner

IL-14s in the 24-seat version were handicapped by the insufficient volume of the baggage compartments for accommodating the passengers' baggage and eventual supplementary cargoes. The problem was solved in 1955 by creating the IL-14M version (M = *modifi**tsee**rovannyy* – modified).

On 22nd September 1955 the Minister of Aircraft Industry issued an order calling for the development of the IL-14M 24-seat passenger aircraft. In December 1955 the IL-14M prototype (СССР-Л1629, c/n 4340506) was submitted for State acceptance trials at GosNII GA (*Gosoo**dar**stvennyy na**ooch**no-is**sled**ovatel'skiy insti**toot** grazh**dahn**skoy avi**ah**tsii* – Civil Air Fleet Research Institute, ex-GosNII GVF); during 14th-23rd April 1956 the same aircraft underwent checkout trials at GK NII VVS. On 18th June 1956 the Council of Ministers issued a directive putting the 24-seat IL-14M passenger aircraft into series production at Plants No.30 in Moscow and No.84 in Tashkent.

The IL-14M differed from the baseline IL-14P primarily in having the fuselage stretched by 1 m (3 ft 3⅜ in); it also featured a strengthened floor structure and new flooring. In addition, there were local reinforcements of the fuselage structure; windows were added between frames 16-17 on both sides of the fuselage. The tail unit and undercarriage remained unchanged. The wing ribs, stringers and skin were reinforced. On aircraft manufactured from 1st February 1957 onwards a new electric system was introduced. Heaters were added in the flight-deck and in the toilet. There were changes in the catering equipment: a galley of a new type was placed at the rear of the passenger cabin. A baggage compartment was arranged on the starboard side between ribs Nos 13-15. Twelve blocks of double seats were installed in the passenger cabin, which was separated from the vestibule by a curtain; fabric curtains were provided on the windows.

The empty weight of the IL-14M was 12,500 kg (27,560 lb) and the service load 640 kg (1,410 lb); the aircraft could carry 24 passengers and 360 kg (794 lb) of baggage. The longer fuselage and higher AUW led to marginally lower performance as compared

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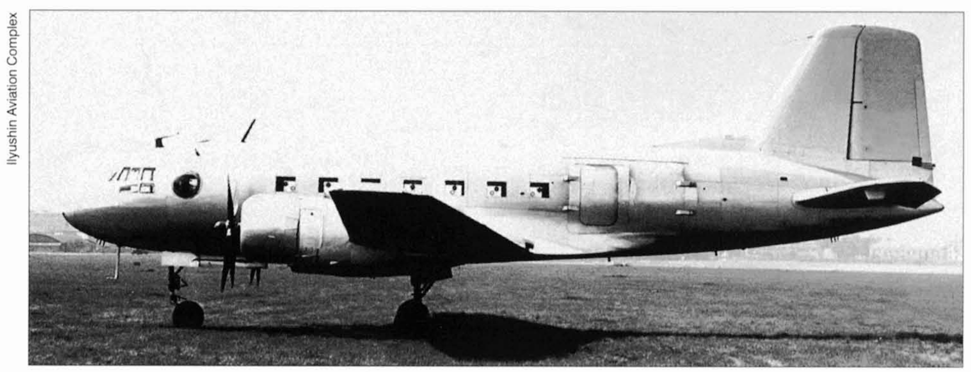

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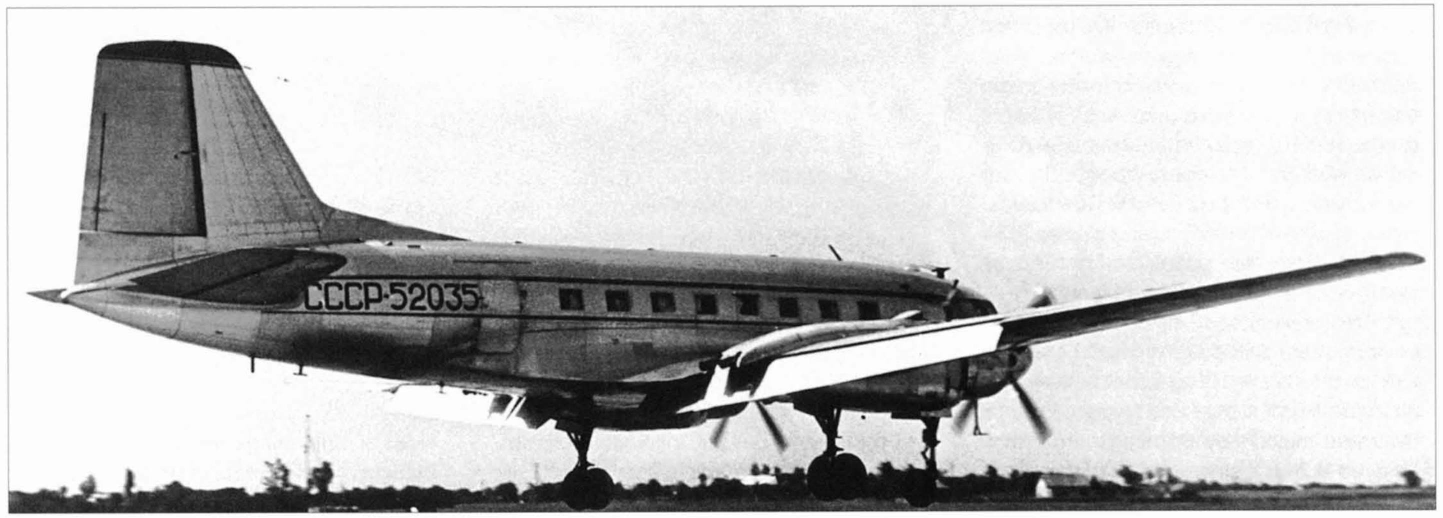
Top and above: The unmarked IL-14-30D military transport/troopship prototype. Note the 'barn-type' cargo door incorporating a paratroop door, the observation blister and the mounting ring for a dorsal turret.



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Seen here moments before touchdown with the flaps fully deployed, IL-14M CCCP-52035 illustrates the longer fuselage with eight cabin windows instead of six. Note how the tail fairings of the engine nacelles incorporating the triple exhaust pipes overlap the flaps.

to the IL-14P: maximum speed fell by approximately 15 km/h (9 mph), rate of climb fell by 0.5 m/sec (98.4 ft/min), there was an insignificant increase of the take-off and landing run. Yet, the ability to safely continue a take-off after an engine failure was retained.

Until the early 1960s the 18-seat IL-14P and 24-seat IL-14M were the main types of Soviet airliners on domestic trunk routes and international services. Not until large-scale introduction of new gas turbine-powered airliners were the IL-14s transferred to commuter services on relatively short routes. Here the IL-14 was operated in layouts featuring a maximum seating capacity which, on the IL-14P, was gradually increased from 24 to 28, and then to 32 seats. On the the IL-14M the number of seats could be 28, 32 or 36. This was achieved by reducing the seat pitch (the seats themselves, as well as other elements of the passenger cabin interior, were now manufactured from new, considerably lighter materials), by reducing the volume of the forward baggage hold, by deleting the galley, and on some machines by deleting the avionics bay on port side of the cabin (the radios were relocated to the navigator's and radio operator's compartments). The greater payload of the IL-14 helped increase its profitability and made it possible to bring down transportation costs and reduce ticket prices on short-haul services.

Export deliveries of the IL-14 commenced on 30th July 1957. In all, 119 Soviet-manufactured aircraft were delivered to 31 nations. IL-14Ps and IL-14Ms were used by the air carriers of Bulgaria, China, Cuba, Egypt, Guinea, Hungary, India, Mongolia, Poland, Romania, Vietnam and Yugoslavia. In March 1954 technical documentation for series production of the IL-14P and IL-14M was transferred to Czechoslovakia (where these aircraft were manufactured under the designation Avia-14) and to the German Democratic Republic (the licence-built versions are described separately).

IL-14M-14 airliner

This version was produced as a derivative of the IL-14M from which it inherited the wings with additional fuel tanks and the fuselage with improved thermal insulation and soundproofing. The tail unit and the undercarriage were identical to those of the IL-14M. Appropriate changes were introduced into the electric system and the radio equipment: new RSIU-5 Doob radios were installed, electric lighting circuits and antennas were altered. The navigator's station was equipped with additional instruments. The aircraft was provided with oxygen equipment. The passenger cabin was equipped with 14 passenger seats and a galley borrowed from the IL-14M.

The aircraft's empty weight was 12,830 kg (28,290 lb) and the operational load 715 kg (1,580 lb), the 1,440-kg (3,175-lb) payload included 320 kg (706 lb) of baggage.

IL-14M-28 airliner

This version was produced as a derivative of the IL-14M and was virtually identical to it structurally. The number of seats in the passenger cabin was increased to 28 by changing the seat pitch. This aircraft was widely used on short-haul services.

IL-14M-32 airliner

This was yet another derivative of the IL-14M. The seat pitch was changed, the galley was deleted, the number of seats in the passenger cabin was increased to 32. Aircraft with this layout were the main type used on local services.

IL-14M-36 airliner

This was the last sub-type of the IL-14M with the highest number of passenger seats. The increase in the seating capacity was achieved by deleting the galley, dispensing with the forward baggage compartment and using more lightweight materials. Only a small number of IL-14Ms were converted to this configuration. Comparing the IL-14P-18 and the IL-14M-36 passenger cabin layouts, one can see what a margin of dependability and airframe versatility this aircraft possessed.

Specifications of the IL-14 aircraft

Type	IL-14	IL-14M
Year of manufacture	1953	1955
Engine type	ASh-82T	ASh-82T
Take-off power rating, hp	2 x 1,900	2 x 1,900
Wing area, m^2 (sq ft)	140 (1,507)	140 (1,507)
All-up weight, kg (lb)	16,500 (36,380)	17,500 (38,590)
Number of passengers	18-32	24-42
Payload, kg (lb)	3,050 (6,725)	3,400 (7,500)
Effective range, km (miles)	1,500 (932)	1,600 (994)
Cruising speed, km/h (mph)	358 (222)	350 (217)
at altitude, m (ft)	2,430 (7,970)	2,000 (6,560)
Take-off run, m (ft)	470-500 (1,540-1,640)	485-550 (1,590-1,800)
Landing run, m (ft)	430-500 (1,410-1,640)	445-500 (1,460-1,640)

IL-14M – patrol version

In accordance with operational requirements issued by the Border Guards of the KGB the design bureau of ARZ No.407 developed the technical documentation for converting IL-14Ms used by the Border Guards into a special border patrol version.

Outwardly such aircraft were identifiable by a conical radome housing a Groza-40 (Thunderstorm-40) weather radar taken bodily from the Yak-40 trijet feederliner, which required the landing lights to be moved down. The IL-14s thus modified were capable of fulfilling promptly and efficiently the tasks tackled by Border Guards; they ensured a much stricter control of the sea areas adjoining the country's coasts, greater flight safety and large-scale instrumental monitoring of objects in the interests of protecting the State borders. The crews of these aircraft felt more confident about their work.

This version's high efficiency was achieved thanks to the upgrading of onboard systems, the installation of up-to-date navigation and search equipment, considerable increase of time on station and ensuring the necessary amenities and comfort for the crew on board the aircraft.

IL-14M – Polar version

In February 1956 a new version of the IL-14M successfully passed manufacturer's tests. It was equipped with two additional fuel tanks in each of the outer wing panels and with a new barometric system. The aircraft was intended for regular non-stop flights between Soviet Antarctic research stations located at a distance of up to 4,000 km (2,486 miles) from each other.

An Arctic version of the IL-14 fitted with retractable ski undercarriage was tested in 1962. The IL-14's ability to perform lengthy flights under the most complicated weather conditions, in rarefied air and at ambient temperatures as low as –70°C (–94°F) and in the conditions of intensive icing, its ability to operate from short ice airstrips, including those picked from the air, ease of maintenance – all this assured this type a long career in the Polar Aviation and even earned it the affectionate nickname *Yevo **V**elich-estvo Led**o**vik Che**tyr**nadtsatyy* – 'His Majesty King Iceman XIV' (a pun on Louis XIV, who is referred to in the Russian language as *Lyud**o**vik Che**tyr**nadtsatyy*).

At the end of the 1970s the IL-14s of the Polar Aviation were actively engaged in providing support for such unique Arctic experiments as the voyage of the nuclear-powered icebreaker *Arktika* to the North Pole and an expedition of a group of individuals on skis to the same destination.

A total of eight IL-14Ms was manufactured in the Polar version.

IL-14FK (IL-14FKP) and IL-14FKM photo mapping aircraft

On 1st December 1955 the Council of Ministers issued a directive ordering OKB-240 to develop a photo mapping version of the IL-14 designated IL-14FK (***fot**okartografich-eskiy* – photo mapping, used attributively); it was to be submitted for State acceptance trials in August 1956. The photo mapping version was evolved from the IL-14P to meet an order from the Soviet Union's Chief Directorate of Geodetics and Cartography.

The IL-14FK prototype converted from a Moscow-built IL-14P (registration unknown, c/n 146000718) first flew on 20th September 1956. It was captained by V. K. Kokkinaki, with G. I. Ulyakhin (from the NII-17 research institute) as first officer and M. S. Gol'dman as project engineer. Joint manufacturer's tests and State acceptance trials took place on 22nd-30th October, with I. V. Musatov from NII-17 as project test pilot and M. S. Gol'dman as project engineer. In all, 48 hours were logged in the course of 21 flights.

In December 1956, concurrently with the IL-14T, the IL-14FK entered production at MMZ No.30. Since it was based on the IL-14P, the designation IL-14FKP was sometimes used. A similar version based on the IL-14M and designated IL-14FKM appeared later. Outwardly they could be identified by twin camera ports closed by protective covers under the centre fuselage and sighting blisters aft of the flightdeck.

The IL-14FK and the IL-14FKM were the first aircraft in the Soviet Union that were designed specially for photo mapping. They were fitted with aerial cameras and a special flight/navigation avionics suite. In the year of 1958 alone, Aeroflot's air survey detachments operating IL-14FKs and IL-14FKMs performed aerial photography of an area totalling 2,300,000 km^2 (888,415 sq miles); the greater part of this area was in the northern regions (Siberia, the Far East) and in Kazakhstan (the virgin soils zone).

The mission equipment installed on these aircraft comprised an AP-6Ye electric autopilot, a KS-6 compass system, an AGI-1S gyro horizon, an APR-2 automatic device for a pre-programmed turn, oxygen equipment for seven crew, special aerial cameras, an additional 1,000-litre (220 Imp gal) fuel tank, an SPU-7 intercom, an OS-1 instrumental landing system, a Landysh-5 VHF radio, an RV-18Zh radio altimeter for high altitudes and a DISS-031FK Doppler speed/drift sensor (only on the IL-14FK).

The aircraft's interior comprised the flightdeck, a navigator/operator's compartment, a radio compartment, a camera operators' compartment and a darkroom. Changes in the instrument arrangement and installation of additional switches and control panels meeting the criteria of ergonomics ensured optimum comfort for the pilots' work.

The navigator/operator's compartment was located between partitions installed at frames 8 and 11. Both sighting blisters housed NKPB collimator sights; the port blister was equipped with an armrest for the navigator's convenience.

The operators' compartment was located between frames 17 and 34. A rest area for the operators was arranged on the starboard side of the compartment in its forward part, comprising two blocks of twin seats with a table between them. Containers of the additional fuel system were placed on the port side of the compartment. The operators' compartment housed an AFA-TE-55 aerial camera and a similar camera on an H-55 hydraulically stabilised mount. These were supplemented by AFA-TA-100 and AFA-33-N-20 cameras mounted on special brackets.

The rear baggage compartment was transformed into a darkroom. For this purpose the window was covered with black cloth, the hatch of the baggage compartment received a rubber lining, the floor was covered with rubber mats.

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IL-14M '05 Orange' wearing a rather unusual combination of basic 1973-standard Aeroflot colours and military insignia represents the patrol version equipped with a Groza-40 nose radar. The aircraft belongs to the Border Guards, as indicated by the horizontal red stripe on the tail.

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Above: '94 Red', the IL-14T prototype, was painted grey overall. This view clearly shows the dorsal turret, the large cargo door, the navigator's blister and the ports in the cabin windows for the troopers' assault rifles enabling the use of the aircraft as a gunship.

A photo cassette rack was placed under the operator's table. The darkroom's equipment made it possible to charge the cassettes and process the films in field conditions. The anti-icing system of the tail surfaces was partially changed. Crew compartments were provided with oxygen equipment, the heating of the cabin itself was considerably improved.

The aircraft's empty weight was 12,880 kg (28,400 lb) and the service load 640 kg (1,411 lb); the photo equipment weighed 355 kg (783 lb). In addition to the crew, two operators handled the mission equipment.

IL-14T military transport

On 23rd June 1954 the Council of Ministers issued a directive requiring OKB-240 to develop the IL-14T military transport aircraft; the machine was to be submitted for State acceptance trials in July 1955. In November 1954 the manufacturing drawings were transferred to the production plant No.84 in Tashkent.

The IL-14T prototype made its first flight on 22nd June 1956, captained by Vladimir K. Kokkinaki, with D. N. Simanovich as engineer in charge of the tests. The manufacturer's tests were completed on 15th August; the appropriate Report was signed on 3rd September. By then the prototype had logged 44 hours in 49 test flights. On 4th September the State acceptance trials of the IL-14T military transport aircraft were officially started at GK NII VVS; they were completed on 30th December (starting on 4th October the State trials had shifted to an airbase near Tula where an airborne troops division was stationed). The transport version entered series production at Plant No.30 in Moscow.

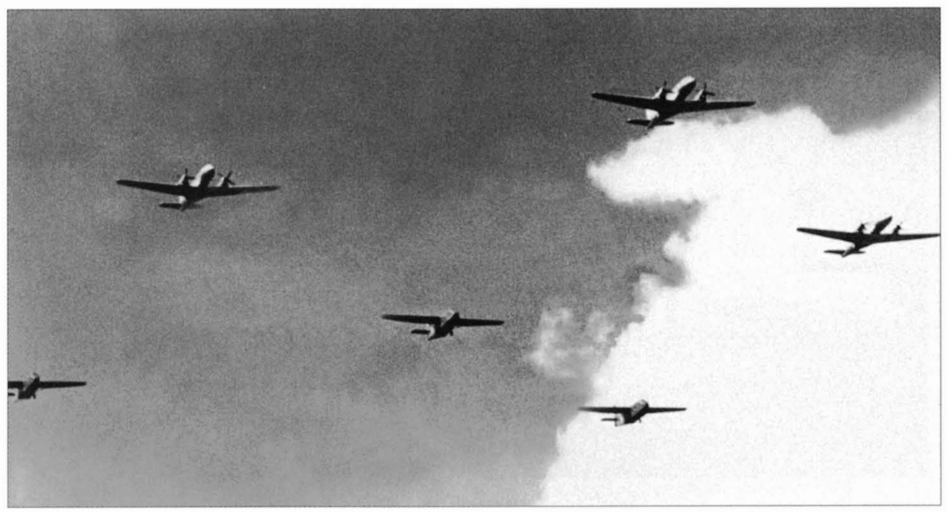
The IL-14T reverted to the 'short' fuselage of the IL-14P. Like the IL-14-30D, it had a double cargo door on the port side of the rear fuselage; the forward half of it incorporated a smaller door for paratroopers.The entry door on the starboard side of the fuselage was widened, opening inwards and aft *à la* IL-12T/D, and was moved forwards from frame 31 to frame 29, with appropriate modifications to frames 29 and 30.

The aircraft was stripped of all passenger equipment (seats, baggage racks, heating and individual ventilation ducts, passenger cabin lamps). Instead, a cargo hold was fitted out; it was enlarged by the inclusion of the space previously occupied by the forward and rear baggage compartments and by reducing the size of the toilet. The forward and rear baggage hatches were deleted.

All the windows of the cargo hold had portholes for small arms and were provided with blinds. In the navigator's compartment the window was replaced by a blister with arm rests. Openings and hatches for an OPB-1 bombsight were made in the floor and the fuselage skin. A window was added in the navigator's cabin in the partition of frame 8. The thermal insulation and soundproofing of the passenger version was deleted, but a more lightweight insulation was used in the cargo hold.

Hardpoints for a towing device were mounted on frame 48; the cutouts for the stabiliser were reinforced accordingly. A hardpoint for the tail support rod was provided on frame 39. Hardpoints for the attachment of two beam-type racks were provided under the wing centre section; the racks could be used for the carriage of external stores.

The IL-14T was fitted with a flight/navigation avionics suite and special equipment matching that of the late-production IL-14M.



Via AVICO-Press

An interesting picture of a trio of Yakovlev Yak-14 assault gliders being towed by IL-14s.

A Proton-M tactical radio navigation system was fitted, with characteristic twin rod aerials between fuselage frames 10-11 and under the outer wings. The IL-14T was operated in different sub-variants which different in equipment fits.

A total of 259 IL-14T aircraft were manufactured; they remained in the Soviet Military Airlift Aviation inventory until the end of 1967.

IL-14TB transport/glider tug

The IL-14T was also used for towing Yak-14 assault gliders. For the purpose of towing one glider or a string of gliders the aircraft was fitted with a towing cable lock controlled by cable linkage. The glider tug version of the IL-14 could be identified by the cut-down tail cone of the rear fuselage; the tail cone was made detachable. This version was designated IL-14TB (for *booksi**rov**shchik* – tug).

IL-14TG transport/cargo aircraft

The IL-14T was also used as a pure cargo aircraft (G = *groozo**voy*** – cargo, used attributively). For this purpose it was fitted with a ladder, a cargo handling platform and a hoist for loading/unloading operations. During flight this equipment was stowed in the cargo hold. In addition, the IL-14TG was equipped with cargo tie-down straps and tie-down fittings were mounted on the floor.

IL-14T-TD transport/assault aircraft

This version was a derivative of the IL-14T (TD = ***trahns**portno-de**sahnt**nyy*, transport/assault, used attributively). The equipment of this version included a P-63 device for paradropping assault cargoes which was installed in the cargo hold. The paradropping container making part of this device was loaded with ten or eleven PDMM-47 cloth bags or ten PDTZh rigid containers. Mounted underneath the wing centre section between the front and centre spars were two detachable beam-type racks for the carriage of droppable cargoes within the dimensions of the FAB-3000 bomb. The cargo hold was provided with a hoist for handling cargoes weighing up to 300 kg (660 lb).

IL-14TD transport/assault aircraft

This version again was a derivative of the IL-14T. Accommodation for 20 paratroopers included ten folding seats on each side of the cargo hold; there was a separate seat on the starboard side for the jumpmaster. The cabin floor was covered with anti-slip rubber mats. Two cables for the parachutes' static lines ran along the cabin under the ceiling. Handrails were mounted along the cabin walls. Alarm bells and signal lamps were installed on partitions placed at frames 13 and 27. Panels with instruments indicating the abandonment of the aircraft by a paratrooper were mounted near the entry door and the paradropping door; lights and buttons for controlling the paradropping warning signals were installed in the flightdeck and navigator's compartment.

IL-14TS transport/medevac aircraft

A medevac version of the IL-14T was produced as the IL-14TS (*sani**tar**nyy* – medical). Provision was made for the installation of 18 standardised stretchers. Amenities for the medical attendant included a folding table on the wall to starboard, two first-aid kits, a lamp, a seat and a hook for the medical bag.

The medevac version of the IL-14 was provided with KP-32 individual breathing apparatus for the patients and the medical attendant and KP-24 breathing apparatus for the crew. In the cabin for the patients there was a water container with an electric heater.

IL-14G cargo aircraft

The IL-14G was the commercial cargo version of the IL-14T featuring minor structural differences. The entry door on the starboard side was enlarged and moved forward. A double cargo door was provided on the port side of the fuselage, but without a smaller paradropping door in the forward section. Ten folding seats were installed in the cargo hold.

The hatches of the forward and rear baggage compartments were deleted, as was the window between frames 28-29. The thermal insulation and soundproofing were deleted, and the heating system and anti-icers were taken from the IL-14T. Oxygen equipment was provided for the five crew and two cargo attendants.

IL-14G Polar version

IL-14s modified for operation in Polar regions were of great help in the mastering of the Arctic and the Antarctic continent. They maintained regular traffic between the mainland and the Polar research stations, including drifting ice-field stations. These aircraft were fitted with long-range fuel tanks in the cabin; underfuselage attachment points for JATO boosters were provided to give short-field capability when operating from ice floes. The cabin was provided with thicker heat insulation, an onboard heater operating on petrol, an auxiliary generator for heating and lighting the cabins on the ground and a gas stove for cooking.

Arctic versions of the aircraft repeatedly underwent modifications designed to adapt them to harsh operational conditions and special requirements of the missions to be fulfilled.

IL-14 ice reconnaissance aircraft

A specialised version of the IL-14 was developed by the design office of the Civil Air Fleet's Aircraft Repair Factory (ARZ – *avia-re**mont**nyy za**vod***) No.407 in Minsk. Its mission was to reconnoitre the optimum routes for ship convoys led by icebreakers bringing priority cargoes along the ice-packed Northern Sea Route. Hence it is sometimes referred to as IL-14LR (*le**dov**yy raz**ved**chik* – ice reconnaissance aircraft).

Outwardly the ice reconnaissance version was identifiable by a ventral teardrop radome under the wing leading edge; this housed an ROZ-1 Lotsiya (Navigational directions) or an Initsiativa (Initiative) ground mapping radar used for measuring the ice's thickness. The aircraft was also equipped with an AP-6Ye autopilot, a KS-6 compass system, a long-range fuel tank in the cabin, an AB-52 drift sight, an S-1 siren and a device for dropping message bags. The aircraft was provided with a hatch for dropping mail and cargoes; the onboard equipment included the Ladoga phototelegraph device, the Neon radio and other special

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This view of Polar Aviation IL-14G CCCP-04179 shows the large cargo door to advantage. Note the navigator's port side blister and astrodome and the cargo hoist in the doorway.

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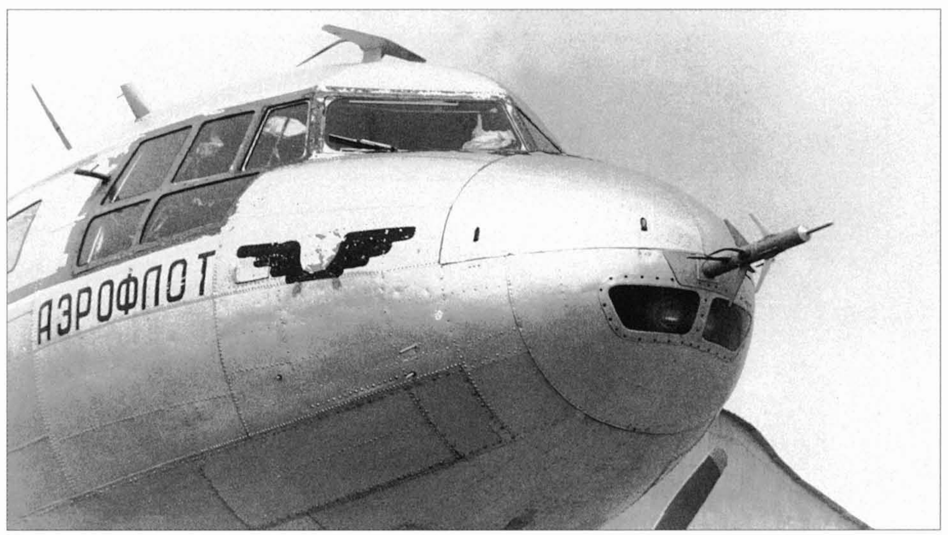
Top and above: This Soviet Air Force L-14P coded '21 Red' is one of several converted to IL-14LIK-1 navaids calibration aircraft. Note the quadruple probe aerials on the nose and the extra dorsal rod aerials.

items of equipment. A special area in the cabin was outfitted for crew rest and taking meals during lengthy flights.

IL-14s conducted ice reconnaissance and search for fish shoals in Arctic conditions at considerable distances from radio beacons and bases. This created certain difficulties for the crews as regards navigation. The need arose to supplement the standard avionics with a versatile compact navigation system with built-in test equipment which would provide the crew with a great number of current parameters within seconds. Such a system, designated ONS-UP Omega, was developed by ARZ No.407; it was fitted to 34 IL-14s used for ice reconnaissance. Known examples were registered CCCP-04177 (c/n 148001902, converted on 27th June 1984) through -04181, -04191, -04198, -41851 (c/n 147001424), -52034 and -61663.

Yefim Gordon archive



Another calibrator version designated IL-14LIK-2 had a smaller set of non-standard aerials. This example features a 'fir tree' aerial.

IL-14RR fishery reconnaissance aircraft

The IL-14RR (*razvedchik ryby*, fishery reconnaissance aircraft) version was developed by ARZ No.407 in Minsk and was intended for the use in the national economy for such duties as fishery reconnaissance, ice reconnaissance, photo mapping, as well as for search and rescue duties and for transporting cargoes and mail to regions difficult to access.

Accordingly, the aircraft was fitted with additional mission equipment; it included a special hatch in the rear baggage compartment which was used for dropping mail, cargoes and message bags. Other additional equipment items comprised an S-1 siren, an NI-50BM ground position indicator, an AB-52 drift sight, an SGU-15 loudspeaker unit. The aircraft was fitted with the Groza-40 radar mounted under the centre fuselage, which gave the IL-14RR a striking similarity to the IL-14LR ice reconnaissance version; the radar's AGB-3K antenna was stabilised. Some sources say the radar was installed in the extreme nose as on the KGB's patrol version, which required the taxi lights to be relocated between frames Nos 2-3.

The passenger cabin was transformed into work stations for hydrologists who were provided with a table, two blocks of twin seats and a small table for meals; there was also a rest area for off-duty crew members. Camera ports with remotely-controlled covers were added on the starboard side of the fuselage. The size of the camera port made it possible to install AFA-TE-36, AFA-TE-100 and AFA-42-20 aerial cameras. Placed on the port side of the cabin was long-range fuel tank holding 1,730 litres (380 Imp gal). If the aircraft was fitted with additional fuel tanks in the wings, the extra tank in the fuselage was not installed.

The rear baggage compartment was modified to incorporate a special door which could be opened inwards and fixed in the open position. This made it possible to drop cargoes and mail at the captain's or pilot/observer's command.

The aircraft was equipped with 1GD-40 loudspeakers from the SGU-15 set for transmitting commands during the dropping of message bags or cargoes; they were supplemented by the S-1 siren. The dropping of cargoes was performed under control from the pilot-observer's work station. All units of the radar installed in the forward fuselage were enclosed by a dielectric nose fairing which was attached to the fuselage with the help of special locks. The Minsk aircraft overhaul plant converted fourteen IL-14s (CCCP-04173, -04310, -41829, -41854, -61620, -61681, -61690, -61691, -61697, -61738, -61752, -61782, -91422 and -91553) into the fishery reconnaissance version.

IL-14 forestry patrol aircraft

A single IL-14LR (CCCP-04177) was converted for forestry patrol duties. No further details are known.

IL-14LIK-1 and IL-14LIK-2 navaids calibration aircraft

Development of these versions of the IL-14 (LIK = ***lyot**no-ispy**ta**tel'nyy **kom**pleks* – flight test complex) was brought about by the introduction of modern navigation aids and air traffic control (ATC) equipment at civil airports. A comprehensive ATC system emerging as a result of these measures comprised various items of equipment installed both on board the airliners and on the ground. To keep up the high level of dependability of the ground-based navigation aids, special flight checker (calibrator) aircraft were developed; they were equipped with a set of instruments for monitoring and assessing the work of these technical means.

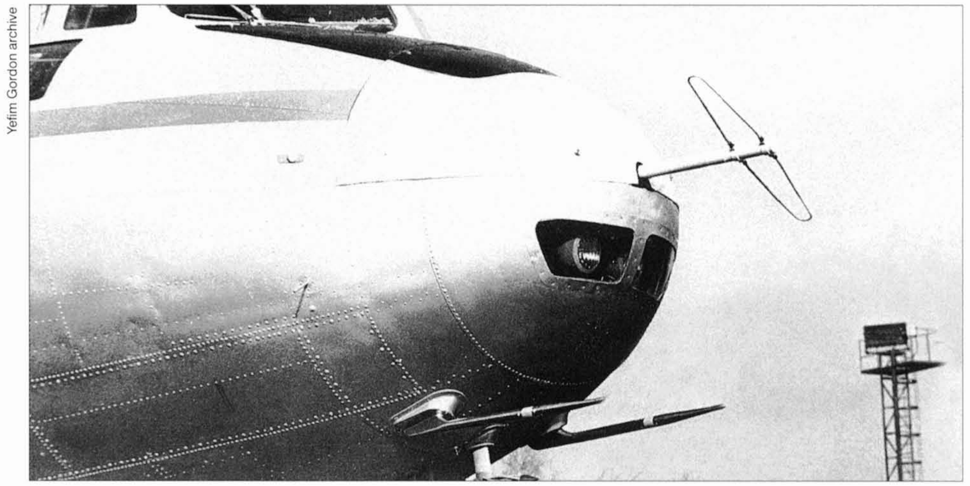
The IL-14LIK-1 and IL-14LIK-2 were converted from IL-14Ms. They were equipped with calibrated instruments making it possible to adjust and monitor the characteristics and efficiency of the ground-based ILS and of radio beacons used for landing, navigation and for secondary radar systems.

The LIK-1 and LIK-2 avionics suites were developed concurrently. The IL-14LIK-1 was equipped with production examples of special equipment which were installed in the aircraft by specialists of ARZ No.407 in Minsk; they also effected appropriate modifications of the aircraft's systems and units.

An-24ALK calibrator aircraft equipped with the ALK-70 avionics suite were capable of monitoring the work of the SP-50M, SP-68, SP-70 and ILS blind landing system beacons. The IL-14LIK-1 could monitor a considerably wider range of ILS beacon types: the civil SP-50M, SP-68, ILS and SP-70, the military RSBN-2N and RSBN-4N, as well as secondary system radars of the Koren', Narva, Utyos and Bazal't types. In addition, the IL-14LIK-2 aircraft could monitor VOR and DME instrument landing systems.

The consoles with the special avionics suites for the IL-14LIK-2 aircraft were developed from scratch by the Minsk aircraft repair plant. The designers and production engineers of ARZ No.407 solved a number of complex problems; they evolved the basic layout of the avionics sets and put them into production. Provision was made for photographing the instruments' readings as the aircraft passed over the beacon to obtain material evidence. The designers developed and put into effect a data collecting and processing system, they started recording the signals on the oscillograph, developed the design and layout for the control of the *Povorot* (Turn) antenna-rotating device which was used for measuring the vertical component of the field intensity of a directional radio beacon.

Yefim Gordon archive



Above: The nose of another IL-14LIK-2 featuring a different antenna array with two probe aerials and a third aerial looking like a commercial TV antenna.

The IL-14LIK-1s were registered CCCP-41803, -52020, -52060, 52061, -52084, -61625, -61692, -61747, -61751, -61753, -61756 (c/n 147001250) and -91598. The IL-14LIK-2s were registered CCCP-04189, -04190, -41804, -41808, -41822, -41849, -41896, -52046, -52052, -61608, -61645, -61662, -61678, -61739, -61754, -61773 and -61778.

Polish IL-14P calibrator version

A single IL-14P registered SP-LNB (c/n 4340510) was operated by the Polish Airport Authority in 1983-89 as a calibrator.

IL-14AKS SATCOM relay aircraft

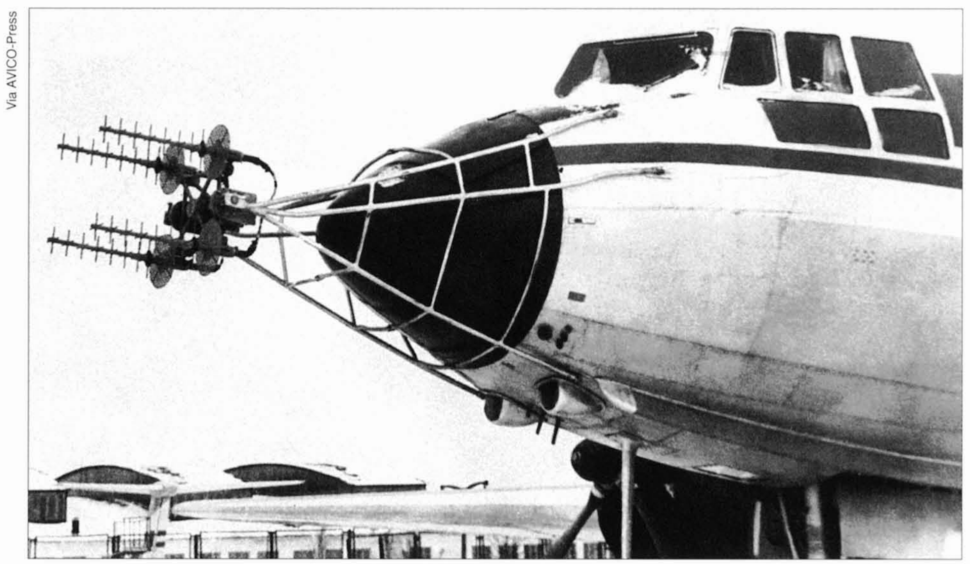
A single IL-14 (identity unknown) was converted into a satellite communications relay aircraft designated IL-14AKS (*appara**too**ra kos**mi**cheskoy **svya**zi* – space communications equipment). It was identifiable by a nose radome housing a Groza-40 radar, around which a truss-like structure was fitted; this carried an antenna array similar to that of the Lichtenstein radar used on Second World War German night fighters.

IL-14 weather research versions

Control of atmospheric processes through active measures designed to influence these processes presupposes a thorough knowledge of what is happening in the atmosphere (of the laws governing the atmospheric phenomena and their causes). Physical research in clouds and the free atmosphere, as well as treating clouds with special chemicals for the purpose of dispersing them and artificially provoking rainfall, is conducted with the help of specially equipped research aircraft.

Special features of the flights conducted by these aircraft necessitated the introduction of appropriate changes into their design and overall configuration, as well as installation of additional systems and equipment.

Via AVICO-Press



Above: The nose of the very special IL-14AKS satellite communications relay aircraft. The aircraft was fitted with a Groza-40 radar before the aerial array was installed.

ITAR-TASS

Above: IL-14FK (note the ventral camera doors) CCCP-91480 was one of at least two converted into geophysical survey aircraft with a towed magnetometer 'bird'.

Sergey and Dmitriy Komissarov archive

Above: Seen here at Leningrad-Pulkovo, CCCP-52029 was the IL-14GGO weather/geophysical research aircraft. This view shows the Groza-40 nose radar, the relocated observation blister and the many sensors.

Yefim Gordon archive

'471 Black' (ex-Interflug DM-SBS, c/n 6341508), an East German Air Force IL-14P, shows the natural metal finish worn by the type in the early days of its career with the EGAF.

All IL-14 aircraft in the 'flying laboratory' (in Russian parlance) series were developed and created (converted from standard machines) by designers and production engineers of the Minsk aircraft repair plant.

The designation *'Il-chetyrnadtsat' Meteolaboratoriya'* (IL-14 weather research aircraft) covered a series of versions produced by ARZ No.407 by converting a number of stock IL-14s; every single aircraft in this series was intended for its own specific tasks and fitted with an equipment suite unique to it. Conversion of each particular machine was effected in conformity with manufacturing drawings and other documents applicable only to the given aircraft.

Depending on the range of tasks to be fulfilled, the individual research aircraft featured their own internal layout and were fitted with additional instruments, such as electrometeographs, hygrometers, thermohygrometers, humidity pulsation sensors, ice formation sensors, zenith ozone meters, electric field intensity sensors, passive radar antennas and the like.

The IL-14 weather research aircraft tackled the following tasks: studying the atmosphere and clouds over a wide range of altitudes, using direct contact and remote sensing methods for measuring the investigated parameters; subjecting the clouds to treatment for the purpose of studying the mechanism of forming artificially induced rainfall; development of cloud-seeding methods; systematic study of the sea surface pollution, of the condition of the country's waterways; development of a system and methods for interpreting and decoding data obtained from space vehicles; studying the characteristics of electric zones in the atmosphere that might pose a danger for air traffic; studying the laws of radio wave propagation in various meteorological conditions; monitoring the work of other aircraft; monitoring the environment for the purpose of discovering polluted zones in industrial areas; assessing the condition of young crops with the help of spectro-photometers for the purpose of forecasting the harvest.

IL-14GGO weather/geophysical research aircraft

Research in the field of cloud and precipitation physics and development of new prospective methods for treatment of the clouds are strongly connected with the use of specially equipped research aircraft. As far back as the 1950s, aircraft were widely used in many points on the territory of the Soviet Union for the vertical probing of the atmosphere with the purpose of obtaining data about the profiles of basic meteorological factors, for studying clouds and precipitation, and the atmospheric electricity.

To back up the research in the field of cloud physics and active influence, IL-14P CCCP-52029 operated by the Leningrad CAD/2nd Leningrad UAD/74th Flight/4th Squadron was converted into a research aircraft for the Main Geophysical Observatory named after A. I. Voyeikov (GGO – ***Glav****naya* *gheofizicheskaya observatoriya*). Hence it is sometimes called IL-14GGO.

Thanks to its fairly low speed (180-300 km/h; 112-186 mph), relatively low operating costs and unpressurised cabin the IL-14 came to be used on a very wide scale for research work in the USSR. However, the rather small payload and limited electric power supply posed stringent requirements concerning the energy consumption and weight of the equipment used for research and limited the number of operators on board the aircraft to 5-7 persons.

The mission suite of the IL-14GGO research aircraft comprised 11 sets of equipment which were intended for meteorological probing, aerophysical measurements, the study of clouds and precipitation, and for artificially provoking rainfall.

The IL-14GGO was capable of conducting the probing for extended periods at altitudes up to 5-6 km (16,400-19,680 ft).

IL-14FK geophysical survey conversion

At least two IL-14FKs (CCCP-91480) were converted for geophysical research, featuring a towed magnetometer 'bird' housed under the fuselage when not in use.

Licence-built versions

Apart from the Soviet Union, the IL-14 was built under licence in Czechoslovakia as the Avia-14 (Av-14) and in East Germany. Oddly, the East German-built IL-14s are habitually referred to as the VEB IL-14, although the acronym VEB (Volkseigener Betrieb – people's enterprise) was a prefix to the name of *any* East German enterprise!

VEB IL-14P airliner

A total of 80 VEB IL-14 aircraft was built by aircraft factory No.803 in Dresden (FWD – Flugzeugwerke Dresden). The VEB IL-14P was the only version fitted with 26 passenger seats; no IL-14s with this seating arrangement were built in the Soviet Union. Structurally the aircraft was identical to its Soviet counterpart.

VEB IL-14S VIP aircraft

A few VEB-IL-14Ps received a VIP interior and were operated by the East German Air Force as Government machines under the designation IL-14S. Two examples serialled '482 Black' and '485 Black' (c/ns 14803035 and 14803027) are known.

RART

Above: Two East German-built IL-14Ps, including '444 Black' (c/n 14803032 – ie, IL-14, plant No.803, 032nd example built in Dresden) in late-standard green/brown camouflage.

Via Thomas Müller

This model represents IL-14P DM-ZZB – the aerodynamics testbed carrying the horizontal tail of the Baade 152 airliner above the fuselage on struts. Note the nose-mounted air data boom.

VEB IL-14T transport aircraft

This was a transport version of the IL-14 based on the Soviet IL-14P version. Several examples of this version were delivered to Poland, the rest were used in the GDR's national economy and Air Force.

Transport versions of the IL-14P manufactured in the GDR usually had no large cargo door to port. At least four East German Air Force machines were equipped with a large upward-hinged cargo door on the starboard side incorporating also the normal entry door. One of these was serialled '405 Black' (c/n 14803043); a civil-registered machine, DM-SAO (c/n 14803079), is also known).

VEB IL-14F photo reconnaissance aircraft

Several East German Air Force VEB IL-14Ps were converted to IL-14F aerial photography (photo reconnaissance) aircraft. An example serialled '411 Black' (c/n 14803002) was modified in 1962; two more machines ('416 Black' and '422 Black', c/ns 14803044 and 14803045) followed in 1965. In addition to aerial cameras, they featured a large nacelle attached under the fuselage which permitted the operator to perform visual sighting. The hemispherical forward glazing of the nacelle was protected from debris by special shutters during take-off and landing.

Letectví + Kosmonautika

Czechoslovak Air Force Avia-14T '3109 Black' (c/n 813109, f/n 121) featured two unidentified ventral fairings. Note that the paradrop door appears to be in the rear half of the cargo door.

Létectví + Kosmonautika

Above: '6102' (c/n 806102, f/n 79) was an example of the rare Avia-14FG 'droopsnoot' photo mapping conversion. Note the remains of the temporary tactical camouflage.

Létectví + Kosmonautika

Avia-14 '1104' was the testbed for the Walter M 601 turboprop/Avia VJ-508 propeller combination. Here it is seen flying on the power of the turboprop engine alone, both radials being shut down and the props feathered.

VEB IL-14 aerodynamics testbed

In 1958 the first VEB IL-14 (DM-ZZB, c/n 14803001) was converted into an aerodynamics testbed for testing the horizontal tail of the Baade '152' jet airliner then under development in the German Democratic Republic. The tailplane was installed on struts above the fuselage. The aircraft was flown without the entry door; the open doorway was used for observing the wool tufts on the undersurface of the tested tailplane and for filming it.

VEB IL-14P flight checker aircraft

The same aircraft, re-registered DM-SAZ, was used later as a flight checker to monitor the navigation aids of airports; additional aerials on the fuselage revealed its new mission. In 1968 this aircraft was replaced in the same role by DM-SAL (later re-registered DDR-SAL, c/n 14803026). One more VEB IL-14P (SP-LNG, c/n 14803010) was operated by the Polish CAA in 1983-89, later going to the Aviation Institute as SP-FNM.

VEB IL-14P navigator trainer

An example of the Dresden-built IL-14P was modified for training navigators, the cabin featuring multiple workstations with navigation equipment.

Avia-14-24 airliner

The IL-14 was also built under licence in Czechoslovakia by the Avia company. The first Czechoslovak-manufactured Avia-14-24 aircraft (OK-KAA, c/n 601101 – that is, year of manufacture 1956, Batch 01, product 1, 01st aircraft in the batch) entered flight test on 14th August 1956. In 1957 the aircraft was presented at the Paris Airshow in the 24-seat configuration, attracting well-deserved attention. Checkout tests of the seventh Avia-14 airliner built (c/n 601107) were completed on 9th May 1957. Some aircraft of this type were later converted to cargo configuration.

A total of 204 Avia-14s was produced in 1956-60; many of them were exported, primarily to the Soviet Union.

Avia-14-32 airliner

This version was based on the Soviet IL-14M with a 32-seat passenger cabin layout. The Czechoslovak version was identical to its Soviet counterpart.

Avia-14-40 (Avia-14-32A) airliner

The Avia-14-40 was a version developed entirely in Czechoslovakia; it featured a seating arrangement for 40 passengers (this version was also known as Avia-14-32A). The seats were arranged in 10 four-abreast rows.

In 1957 this aircraft was demonstrated at the Paris Airshow were it received a high appraisal from specialists. The increase in seating capacity was achieved by using more light-weight materials and onboard equipment thanks to which the empty weight of the aircraft was reduced by 800 kg (1,764 lb). The tasteful interior design and state-of-the-art flight/navigation and radio equipment, coupled with good performance and excellent stability and handling, made the Avia-14 airliner competitive on the world market.

Avia-14 Salon (Avia-14S) VIP aircraft

This aircraft, sometimes called Avia-14S, was based on the Soviet IL-14S VIP version for 6-8 passengers. One Avia-14S was delivered to Guinea where it was used as the Presidential aircraft (hence the registration 3X-PRG for *Président de la République de Guinée*).

Avia-14 Super airliner

This version was developed in Czechoslovakia, making its first flight in 1959. The appellation Super applied to three versions.

The Avia-14 Super-32 was intended for medium-haul international services and had 32 passenger seats.

The Avia-14 Super-36 was intended for short-haul international services and had 36 passenger seats; aircraft of this version were exported to Guinea, the USSR, Mongolia and Bulgaria.

The Avia-14 Super-42 with a 42-seat passenger cabin was used on short-haul domestic services.

The Avia 14 Super aircraft could be identified by the circular windows and the cigar-shaped additional wing-tip fuel tanks.

Avia-14 flight checker

A single Avia-14-32 registered OK-LCE (c/n 703113) was converted into a flight checker to monitor the navigation aids of airports and was used for this purpose by the ČSSDL (Czechoslovak Directorate of Civil Airfields) between 1960 (1966, according to other sources) and 1977.

Avia-14T transport aircraft

This version was based on the 'stretched' Avia-14-32 and was structurally similar to the Soviet IL-14T. The cargo hold was 12.95 m (42 ft 5⅞ in) long, 2.65 m (8 ft 8⅜ in) wide and 1.95 m (6 ft 4¾ in) high. A cargo door measuring 2.75 x 1.60 m (9 ft ¼ in x 5 ft 3 in) was located on the port side of the fuselage. The prototype of the Avia-14T was flown in 1958. It differed from its Soviet counterpart in being fitted with external wing-tip fuel tanks.

Avia-14F aerial photography aircraft

This version developed in Czechoslovakia appears to be a straightforward adaptation of the basic IL-14 airframe similar to the Soviet IL-14FK and IL-14FKM; it differed from its Soviet counterparts in the mission equipment. Several examples were supplied to China.

Avia-14FG photo mapping aircraft

This version, also known as IL-14FG, made its appearance in the second half of the 1960s. It featured a redesigned bulbous glazed nose which provided accommodation for the navigator. The passenger cabin was used for the mission equipment, including aerial cameras and a darkroom for processing films in flight. A dozen machines of different versions, including the Avia-14-24, Avia-14-32 and Soviet-built IL-14s, were converted to this configuration by the Aero Vodochody factory. Known examples were serialled 1103, 1105, 1106, 3111 and 6102.

Avia-14 navigator trainer version

In the early 1960s two examples of the Avia-14T were converted into navigator trainers. The aircraft were equipped with a nose radar enclosed by a thimble-shaped radome and had three big astrodomes above the fuselage. One of these aircraft, serialled 3147 (c/n 913147, f/n 171), was later reconverted to the transport version.

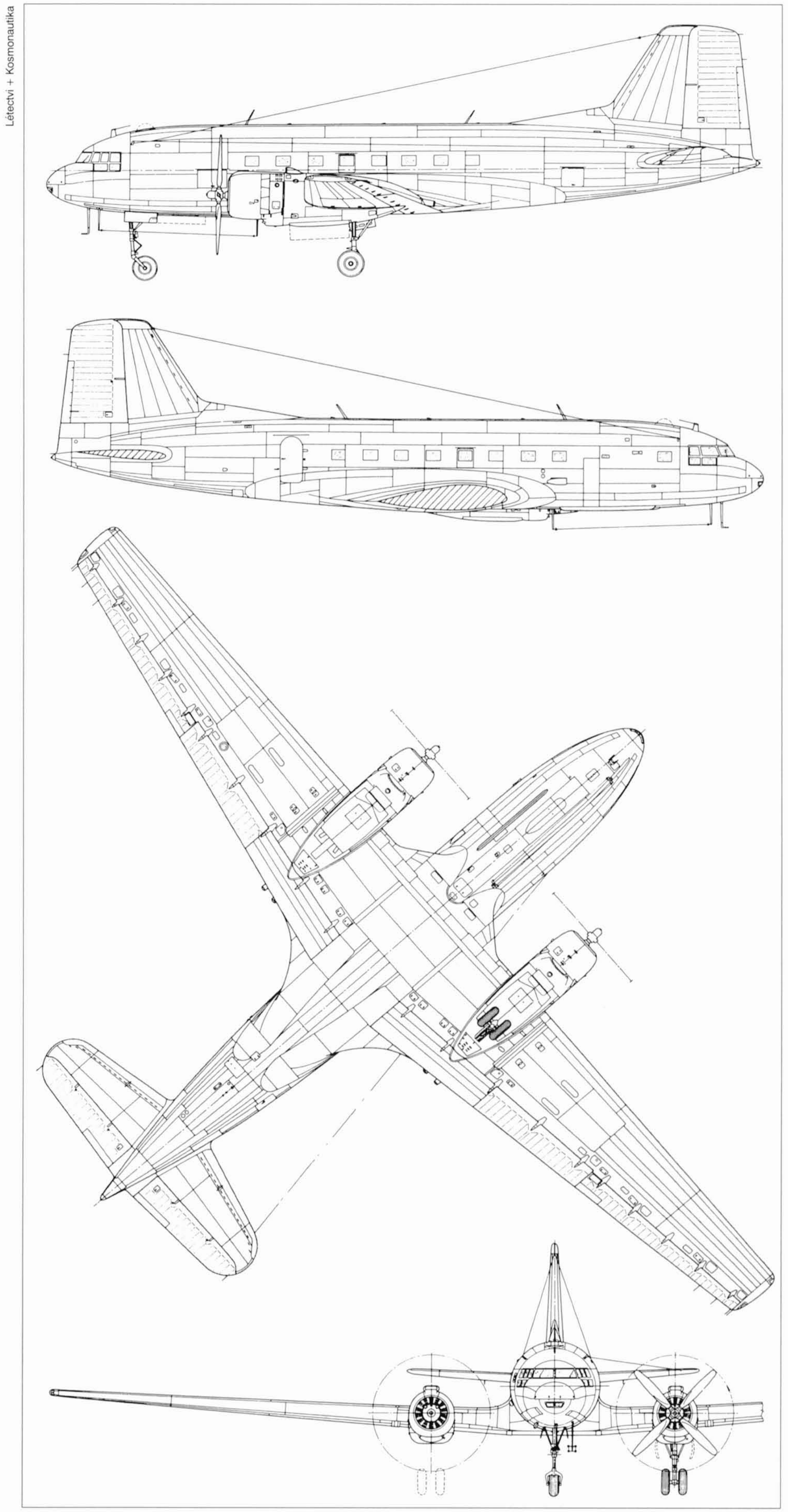
Avia-14 engine testbed

A single Czechoslovak Air Force Avia-14 serialled 1104 (c/n 601104, f/n 04) was converted into an engine testbed by VZLÚ (*Výzkumní a zkušební létecký ústav* – Flight Research and Test Establishment), the Czechoslovak counterpart of LII. The aircraft served for testing the Walter M 601 turboprop engine developed for the Let L-410A Turbolet feederliner. The turboprop was mounted under the nose, driving an Avia VJ-508 three-bladed propeller.

In all, 839 IL-14s of 40 different versions were built by two Soviet factories; in addition, 204 aircraft were manufactured in Czechoslovakia and 80 in East Germany. The NATO reporting name was *Crate*.

The machine was steadily improved during the whole period of production and even after its termination. For example, flight tests of the IL-14P with an AUW of 18,000 kg (39,690 lb) began on 14th July 1959.

The IL-14 remained in operation until the early 1990s. The variety of missions fulfilled by its many versions in the course of such a lengthy period testifies to their high performance and operational qualities and places the IL-14 among the outstanding examples of aviation hardware.



Létectví + Kosmonautika

Four views of the Avia-14

The IL-12 and IL-14 constituted a whole epoch in the development of the Soviet Civil Air Fleet. In the course of the first post-war decade they ensured the expansion of the network initially of domestic and international trunk services and subsequently of commuter services as well. A growth of the IL-12 and IL-14 fleet, and an increase in the intensity of flights on air routes ensured a considerable increase in the volume of passenger traffic. Other contributing factors were the IL-12's and IL-14's higher level of dispatch reliability as compared to the Li-2, and more advanced radio navigation equipment which, in combination with the development of a system of ground-based radio devices, enabled Aeroflot pilots to quickly master scheduled passenger flights in adverse weather conditions and at night, including instrument landing approach. Introduction of the IL-12 and IL-14 into service was to a large extent a determining factor in shaping the level of the airports' technical equipment; it necessitated the creation of a system of preventive maintenance of aircraft in accordance with specially prescribed procedures and dictated an improvement in the organisation of repair services.

Several IL-14s were preserved as monuments at air bases and airports. In October 1984 a Soviet Air Force IL-14 coded '01 Red' (c/n 147001621) manufactured on 18th October 1957 was inaugurated as a monument at Ivanovo-Severnyy AB, home of the Military Airlift Aviation's 601th Combat & Conversion Training Centre (named after Air Marshal Nikolay S. Skripko on 6th May1995) in Ivanovo. On 28th June 1988 an IL-14 operated by MAP with the non-standard registration CCCP-64455 was erected as a monument in Krasnaya Gorka township, Nuriman Region, Bashkiria. The aircraft was ferried to its final resting place by a crew captained by I. V. Ognev. One more IL-14 was placed on a plinth as a monument at Mys Schmidta (Cape Schmidt) airport on 30th September 1991.

IL-18 4ASh-73 airliner

In the spring of 1945, when the first prototype of the IL-12 was under construction, Ilyushin embarked on the development of a four-engined airliner with a considerably higher seating capacity. It was allocated the designation IL-18 (the first aircraft to be thus designated). Conceived as a high-altitude long-haul airliner, the aircraft was initially intended to be powered by four Charomskiy ACh-32 diesel engines.

The basic specification set out the following parameters: number of passengers, 60-65; range, up to 5,000 km (3,108 miles); cruising speed, 450 km/h (280 mph); operational altitude, 7,500 m (24,600 ft). The plans in hand at that time envisaged putting a relatively limited number of IL-18 aircraft into operation to supplement the Li-2P and IL-12 airliners which were to be the backbone of Aeroflot's fleet; these two types were to be used mainly on short- and medium-haul services. As for the IL-18, it was intended for Aeroflot's long-haul domestic and international routes. This meant that the aircraft would fly from Moscow to such destinations as Baku, Tbilisi and Yerevan in the Transcaucasian region, Tashkent, Alma-Ata and other cities in the Central Asia, to industrial centres in the Urals and further to the Far East. This kind of planning marked a new stage in the development of the Soviet air transport: for the first time the prospective structure of the fleet was determined proceeding from a comprehensive assessment of traffic requirements.

In its overall configuration and many design features the IL-18 bore a strong resemblance to the first, four-engined project version of the IL-12. In particular, their common feature was the parabolic nose which was completely faired into the fuselage, without a break at the flightdeck windows. However, the new aircraft was considerably larger and heavier.

The IL-18's design philosophy was largely based on the principles incorporated in the IL-12; however, the designers sought to achieve still higher characteristics as regards the wings' lift/drag ratio and maximum speed. To obtain this result, the wings featured an aspect ratio of 12 – an unusually high figure. The wing loading was 310-340 kg/m^2 (63.55-69.7 lb/sq ft), which was also a fairly high value for this class of aircraft at the time. The design staff had to display much ingenuity solving a number of tough engineering tasks in order to ensure the necessary strength and stiffness of the wings possessing the above-stated parameters.

The aircraft was intended for operations from paved and unpaved runways with a length of less than 1,000 m (3,280 ft). Accordingly, the IL-18 was provided with high-lift devices (slotted Fowler flaps) and appropriately sized undercarriage wheels. To reduce drag and increase the rate of climb, the mainwheel well doors were closed immediately after the undercarriage was extended (the nose gear doors remained open).

The flightdeck and the passenger cabin of the IL-18 were pressurised; the pressurisation air was tapped from the engine turbosuperchargers. The fuselage had a circular cross-section, measuring 3.5 m (11 ft 5¾ in) in diameter; this cross-section made it possible to use the space under the floor of the passenger cabin for cargo and baggage compartments. The chosen fuselage diameter proved to be appropriate also in most other respects; later this diameter was used again for the 'second-generation' IL-18 turboprop airliner described in Chapter 4 (which, otherwise, had no structural commonality with its piston-engined namesake).


Ilyushin Aviation Complex

This view of the as-yet unregistered 'first-generation' IL-18 prototype emphasises the short landing gear wheelbase, the aircraft looking distinctly tail-heavy. Note that both entry doors are on the starboard side, following the standards of the time – something that would change on the turboprop-powered 'IL-18 Jr.'.

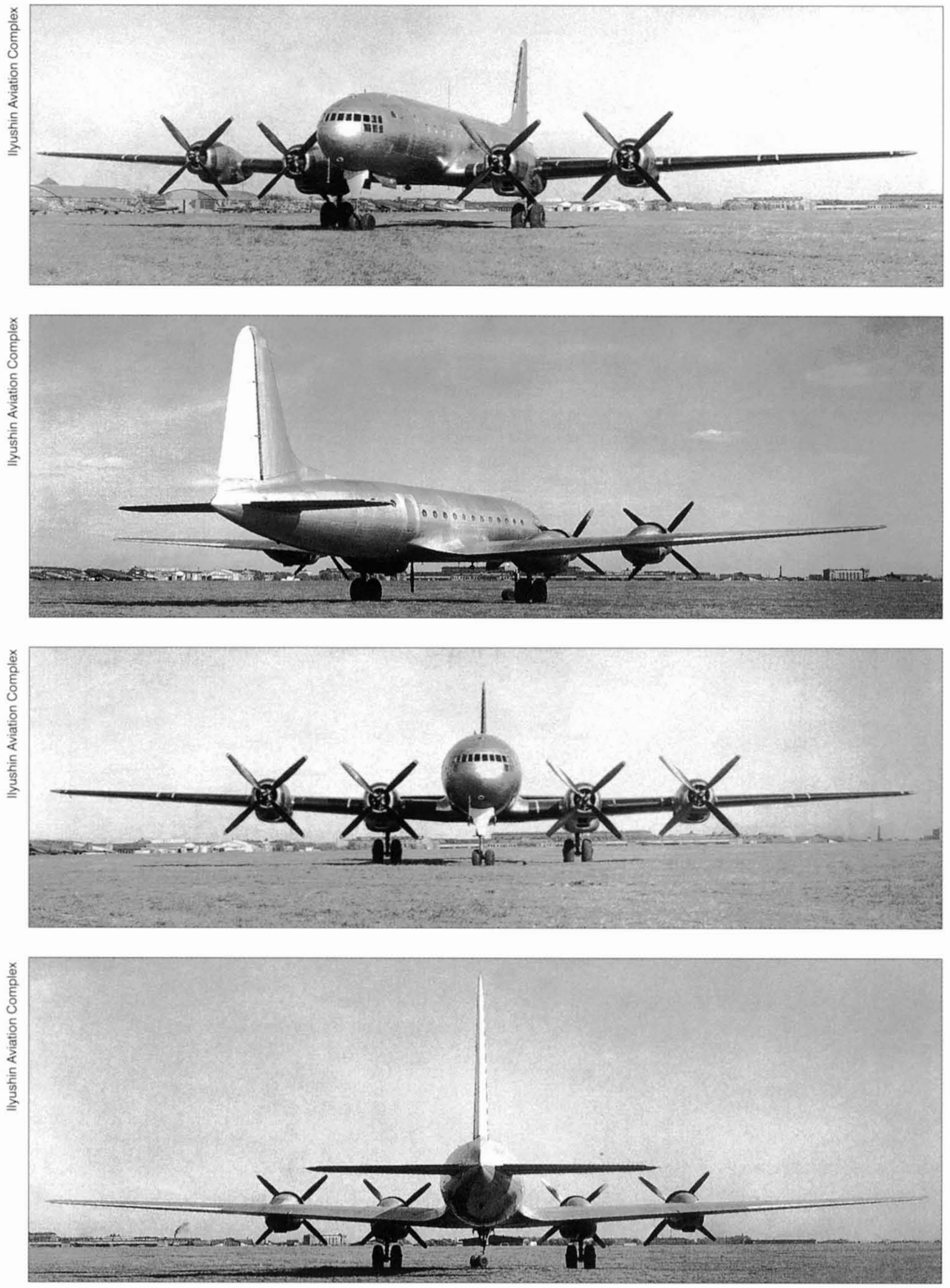
Designing a pressurised fuselage of such large dimensions (its volume reached 130 m^3/4,592 cu ft) was a novel task for Soviet designers. The Ilyushin OKB design staff had to solve a number of basic problems associated with developing a structure of this kind; matters of primary concern were structural strength, reliability and operational safety. In many cases the engineers performed pioneering work and offered solutions that set new standards in Soviet design practice. In particular, the parabolic shape of the forward fuselage so characteristic of this aircraft was chosen because of the need to use structures capable of withstanding the pressure differential inside the pressurised fuselage. Crucially important was Ilyushin's decision concerning the choice of window shape. Initial project envisaged the use of rectangular windows, but static tests revealed their propensity for forming cracks in the corners which might cause catastrophic structural failure after numerous stress cycles of the pressurised fuselage. Ilyushin opted for circular windows, and the wisdom of this decision was fully borne out subsequently.

The pressurised part of the fuselage of the IL-18 comprised the flightdeck with the workstations of the pilots, radio operator and flight engineer; this was followed by the passenger cabin, toilets, a galley and two baggage/cargo holds. The passenger cabin was projected in several seating layouts. The baseline layout featured 66 first-class seats. In addition, there was a layout with 40 seats of enhanced comfort and a version for night flights with 27 sleeping berths – no doubt inspired by the DST (Douglas Sleeper Transport) version of the DC-3.

In the summer of 1945, after the first flight of the IL-12 prototype in its diesel-engined form, a decision was taken to replace the ACh-32 diesels of the IL-18 with Shvetsov ASh-73 18-cylinder air-cooled radials with TK-19 turbosuperchargers running on gasoline. This engine with a take-off rating of 2,400 hp was already being phased into series production. On the IL-18 the engines drove AV-16NM-95 four-blade variable-pitch propellers.

On 1st March 1946 deputy Chief Designer V. N. Bugaiskiy was appointed chief project engineer for the IL-18. A. P. Vinogradov was appointed engineer in charge of the flight tests.

The IL-18's avionics and equipment suite enabled it to operate in the daytime and at night under adverse weather conditions. Flight safety was catered for by the installation of a radio navigation system and by the provision of anti-icing for the flight-deck glazing, propeller blades and wing/tail unit leading edges. The electro-thermal anti-icing system used on the IL-18 was a novel design for its time; it consisted of sections of current-conducting rubber mounted on the leading edges of the wings, stabiliser and fin; these rubber sections were heated by four engine-driven electric generators. In addition to the electro-thermal system, a hot-air anti-icer was designed for the IL-18; it was similar to the anti-icer used on early-production IL-12s.


Ilyushin Aviation Complex
Ilyushin Aviation Complex
Ilyushin Aviation Complex
Ilyushin Aviation Complex

Four views of the IL-18 4ASh-73TK prototype, showing the tall tail, the small nosewheels, the nose gear door design identical to that of early IL-12s and the aft position of the engines' oil coolers.

Construction of the first IL-18 prototype was completed in the summer of 1946. Originally bearing no markings whatever, it eventually received the registration CCCP-Л1789. The sixty seats were arranged in 12 rows, five-abreast (2+3). The ASh-73 engines installed on the aircraft were not yet fitted with turbosuperchargers because of delays in the latter's development. To save time, Ilyushin gave orders to start the testing of the IL-18 with unsupercharged engines having an altitude rating of only 2,000 m (6,560 ft)

On 17th August 1946 a crew captained by test pilot Vladimir K. Kokkinaki took the aircraft into the air for its maiden flight. Interestingly, the other two crew members were the pilot's brothers: Konstantin K. Kokkinaki was co-pilot, while Pyotr K. Kokkinaki was flight engineer. The first impressions were favourable: the take-off presented no difficulties, the take-off run and lift-off proceeded smoothly. The IL-18 demonstrated good stability during climb; when trimmed by means of trim tabs, it flew without large forces on the

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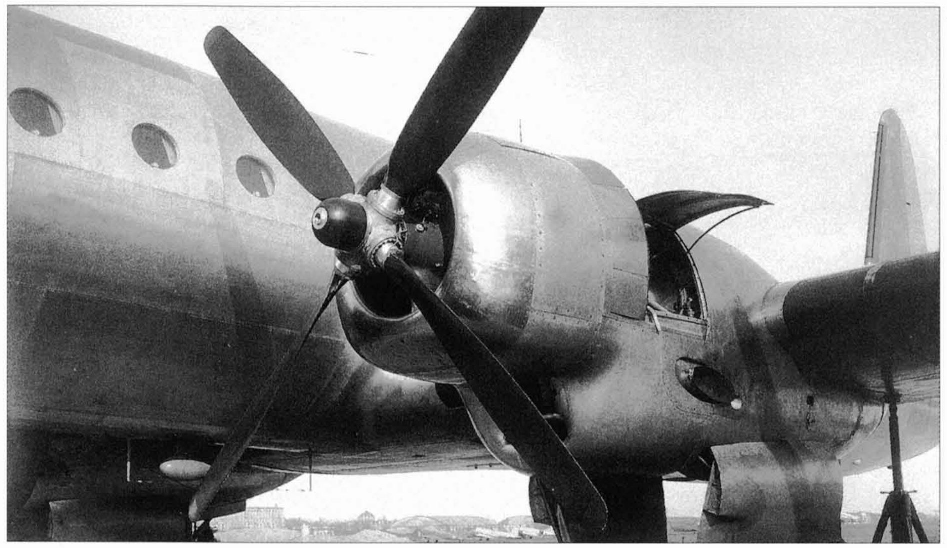
Above: The cabin of the IL-18; the large diameter is readily apparent. Note that each seat has handles flanking the headrest.



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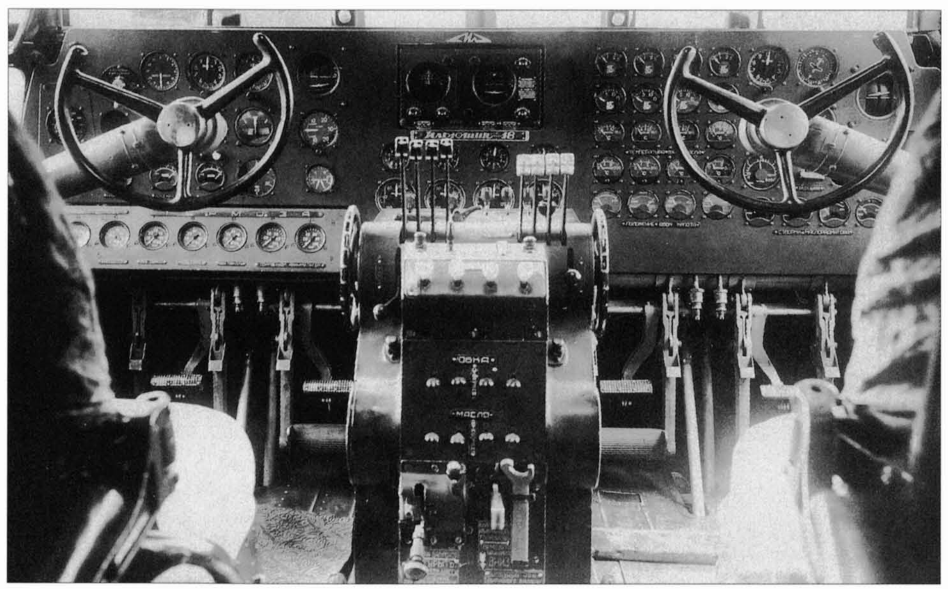
Above: Close-up of the No.2 engine with one of the cowling panels open; the nacelles are similar in shape to the 'Andy Gump' nacelles that appeared later on the Boeing B-50. The aircraft is jacked up for landing gear checks.



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The flightdeck of the IL-18. Note the design of the control columns; it would be reused a decade later on the turboprop IL-18. Note also that the aircraft type (Ilyushin-18) is etched on a plaque above the throttles.

controls. In level flight the well-trimmed aircraft flew in a straight line with the pilot's hands off the control column at speeds between 250 km/h (155 mph) and the maximum speed. The longitudinal control forces made for pleasant handling, aileron control was easy. Descent of the IL-18 was uneventful, the landing was simple, the aircraft displayed good stability during the landing run and had no vices.

The test personnel also lavished praise on the comfort in the passenger cabin. Noise levels in the cabin with the engines running were considerably lower than in the Li-2, Douglas C-47 and IL-12. A passenger sitting in line with the running engines could speak to his neighbour without raising his voice. In winter time the heating system created normal room temperature throughout the cabin.

In the autumn of 1946 the tempo of the manufacturer's tests slowed down. The reason was the unavailability of the high-altitude ASh-73TK engines fitted with turbosuperchargers; without these, the programme of the IL-18 prototype's testing could not be fulfilled completely. Nevertheless, factory test pilots continued to examine the machine's special features and bring to light its weak and strong points.

Eventually the ASh-73TK engines became available, and the aircraft (referred to in this guise as the IL-18 4ASh-73TK) completed its manufacturer's test programme on 30th July 1947, whereupon it was submitted to GosNII GVF for State acceptance trials. During the manufacturer's tests the aircraft attained a maximum speed of 565 km/h (351 mph) at the altitude of 9,000 m (29,520 ft) and at the normal AUW of 42,500 kg (93,710 lb). The cruising speed was 450 km/h (280 mph). The aircraft's payload reached 7,600 kg (16,360 lb) at an overload AUW of 47,500 kg (104,740 lb). The effective range was 6200 km (3,853 miles).

The IL-18 powered by ASh-73 engines with AV-16NM propellers was a promising aircraft, as far as its performance was concerned. Its structure was stressed to 5g, which guaranteed flight safety during operation under adverse weather conditions. At an all-up weight of 42,500 kg the IL-18 could perform sustained level flight and even a climb with three engines running; at an AUW of 36,000 kg (79,380 lb) it could perform level flight with two engines running.

Nevertheless, the IL-18 was not manufactured in series. The ASh-73TK engines were in short supply, being badly needed to power the Tu-4 bombers which had entered production at that time. Besides, these engines were not yet sufficiently reliable for a passenger aircraft. During the testing the ASh-73s installed in the IL-18 prototype had a service life of only 25 hours, later extended to 50 hours, and ran on imported gasoline. In the course of testing there were cases when chips were discovered in the oil filters, and on 25th June 1947 one of the engines disintegrated on take-off.

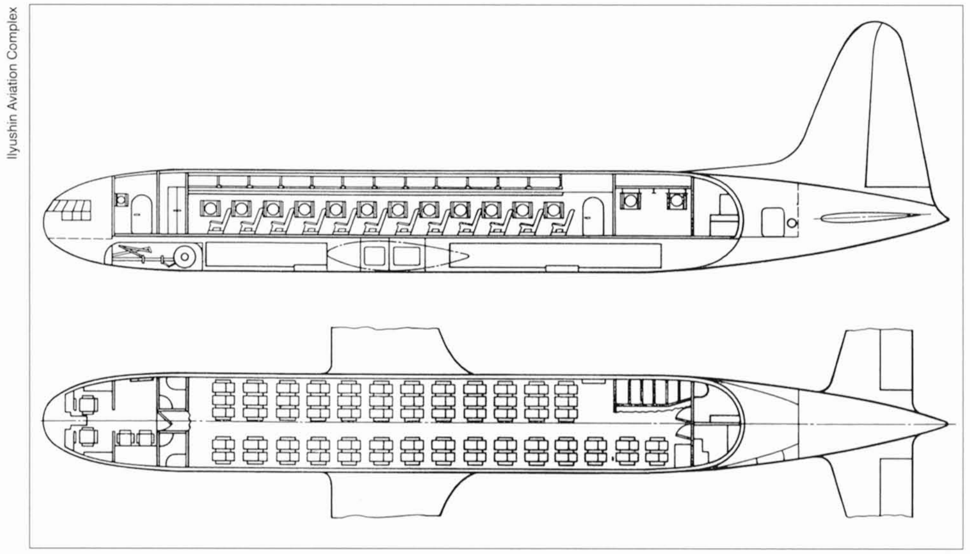
Interestingly, in addition to its civil airliner role the IL-18 was also intended to fulfil the role of a military transport (troop carrier). A directive calling for modification of the IL-18 into this version was issued by the Soviet Council of Ministers on 1st April 1947. Presumably this variant was abandoned when plans for the series manufacture of the type were cancelled.

On 3rd August 1947 the IL-18 prototype was shown at the annual Air Display in Tushino, leading a line-astern formation of IL-12 airliners. Subsequently the aircraft participated in various test programmes. In August-September 1948 it was fitted with a special device and converted into a glider tug, it was used for some time for towing the prototype IL-32 heavy transport glider. Subsequently it performed occasional flights well into the early 1950s.

Experience gained during the construction and testing of the piston-engined IL-18 had a considerable influence on the project-ing of its better-known stablemate, the turboprop-powered IL-18. The latter, while retaining the same designation, was in fact a completely new airliner embodying a considerably higher level of aircraft design.

IL-32 transport/assault glider

During the early post-war years much attention was given by the Soviet Air Force command to the development of heavy transport gliders as a means of delivering assault troops. Several design bureaux were entrusted with the development of such gliders; the Ilyushin OKB was one of them. On 20th September 1947 the Council of Ministers issued a directive tasking Ilyushin with developing the IL-32 transport and assault glider capable of carrying a 7,000-kg



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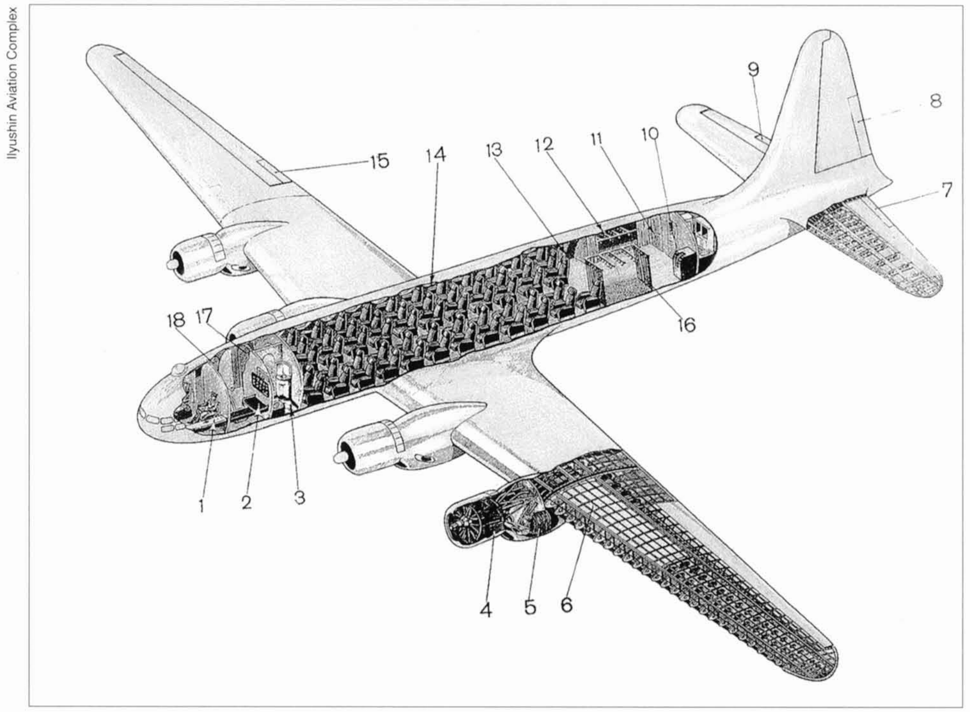
Above: This diagram illustrates the IL-18's interior layout in the baseline 66-seat version. Note the No.3 baggage compartment in the extreme tail, outside the pressure cell.



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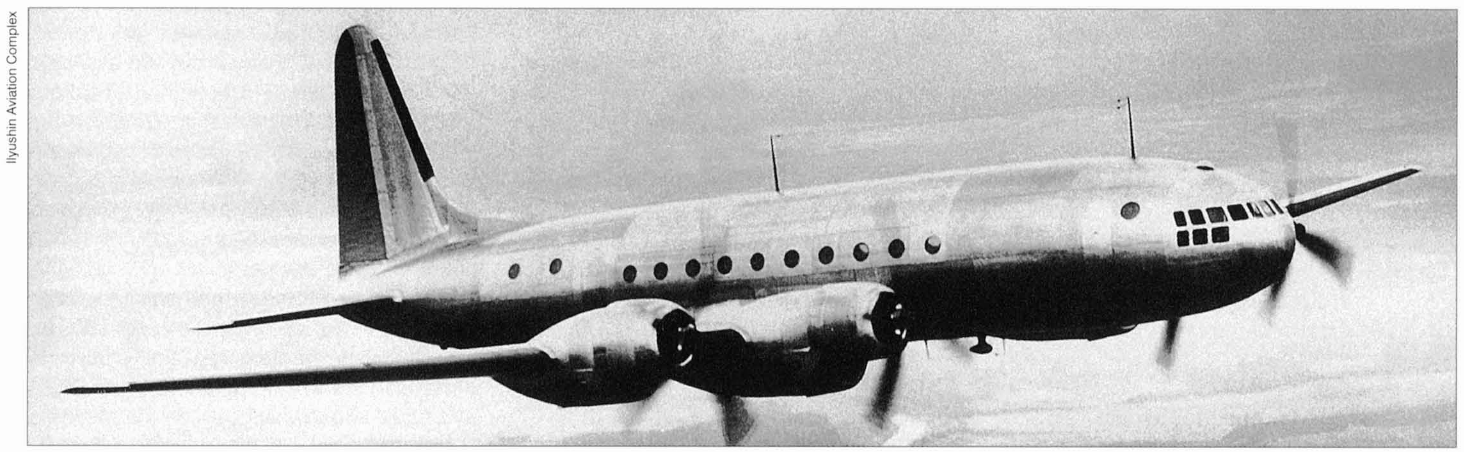
Above: A cutaway drawing of the IL-18 from the project documents.



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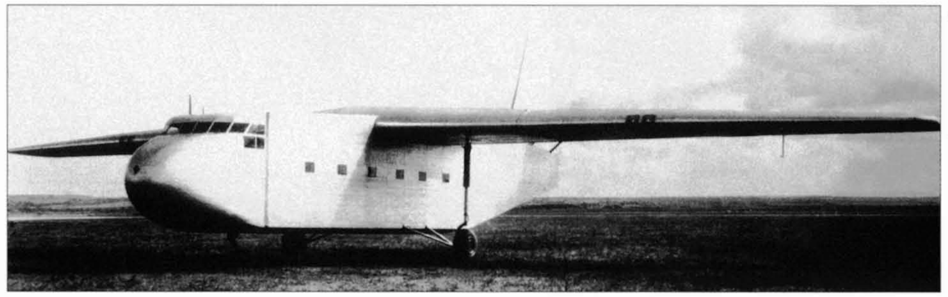
An air-to-air of the IL-18 during trials



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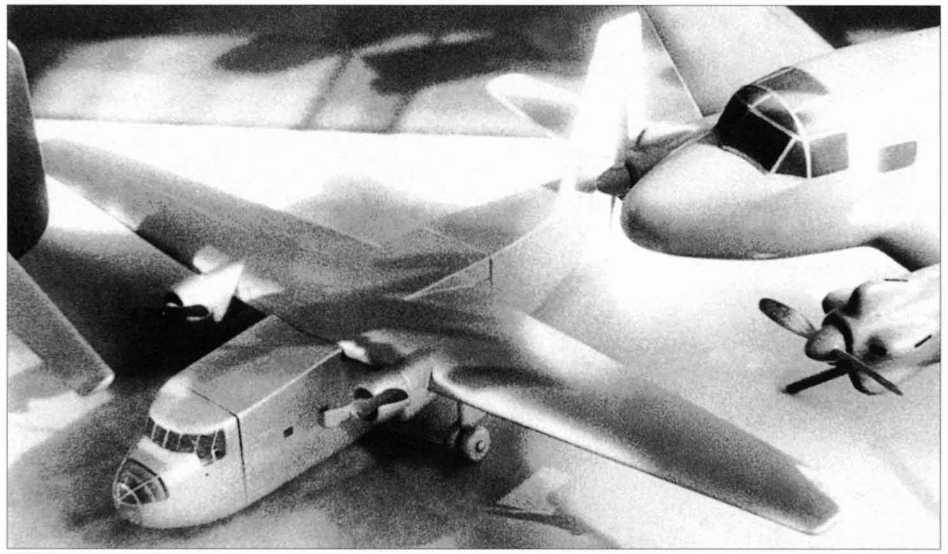
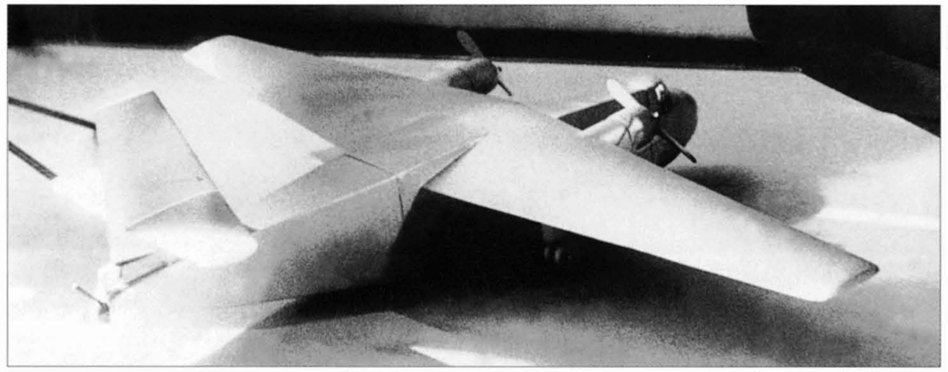
Above: The prototype of the IL-32 assault glider – a grim-faced aircraft if there ever was one. Note the hinge line immediately aft of the flightdeck.



Sergey Komissarov



Sergey Komissarov

Top and above: This model of the IL-34 displayed at the Central Armed Forces Museum in Moscow shows the location of the rear fuselage hinge line and the tail gun turret for self-defence.

(15,430-lb) payload. It could accommodate 60 troops with personal small arms; the glider was also intended to transport heavy fighting vehicles, such as ASU-76 self-propelled guns and 122-mm cannon with their tractors, ammunition load and crew. The IL-32 was to be towed by the Tu-75 four-engined transport aircraft which was under development in Tupolev's OKB at the time.

The IL-32 was an all-metal high-wing cantilever monoplane with fixed landing gear; its traditional-type tail unit included a strut-braced horizontal tail. The fuselage had a square cross-section. The two-spar wings featured a moderate aspect ratio and were fitted with ailerons, spoilers and trailing-edge flaps. The glider was envisaged as expendable and featured a very simple structure to make sure it could be easily manufactured in large numbers – the same design philosophy had gone into the Second World War-vintage Airspeed Horsa and Waco CG-4. To facilitate loading and unloading, the fuselage incorporated hinged nose and tail sections which could be swung to starboard at an angle of up to 95°. The same purpose was served by the use of the so-called 'kneeling' undercarriage which enabled the glider to sit on the fuselage during cargo handling or to land on the fuselage in case of need (to ensure a safe landing on a rough terrain).

The first prototype IL-32 was completed by the early summer of 1948, but the beginning of the manufacturer's flight tests was delayed by difficulties in procuring a sufficiently powerful glider-tug. The twin-engined IL-12 airliner was considered inadequate for the purpose, and preparations were started for adapting the IL-18 4ASh-73TK airliner prototype for this role. In the meantime, Ilyushin OKB chief test pilot Vladimir Kokkinaki took the risk of using the IL-12 as a tug at his own initiative. On 20th August 1948 this IL-12/IL-32 combination lifted off the ground for the first time with V. K. Kokkinaki at the controls of the glider, while the tug aircraft was piloted by his brothers K. K. Kokkinalti and P. K. Kokkinaki. The IL-32 performed a few more test flights behind the IL-12 at a reduced all-up weight. From 20th September 1948 onwards they were followed by test flights behind the IL-18. With the IL-32 at an all-up weight of 16,000kg (35,280 lb), a cruising speed of 327 km/h (203 mph) was attained at 3,000 m (9,840 ft).

The test results were considered to be quite satisfactory, and preparations were made for putting the IL-32 into production. However, the tug aircraft problem remained unresolved: the Tu-75 transport was not yet available, the Tu-70 and IL-18 four-engined airliners were not placed in series production, and the Tu-4 bomber had been built in too small numbers to be diverted for this purpose. Experiments were made to study the feasibility of towing the IL-32 behind two IL-12D transports flying in an extremely tight echelon formation. The scheme was initially tested with two Li-2 aircraft towing a Tsybin Ts-25 glider; this was followed up by several flights of the IL-12s in close formation without a glider. It became clear that piloting the tug aircraft in this configuration was very difficult and involved much risk. The IL-32 was doomed to remain redundant, and plans for its series manufacture were cancelled.

IL-34 transport/assault aircraft (project)

This derivative of the IL-32 glider powered by two ASh-82F radial engines driving two-bladed propellers was proposed by Sergey V. Ilyushin in late 1948. Featuring an airframe virtually identical to that of the glider, the new aircraft possessed the same capabilities as regards the number of troops to be carried and the types of military hardware that could be accommodated in its cargo hold. The aircraft retained such features of the glider as the 'kneeling' fixed undercarriage and the hinged nose and tail fuselage sections. Apart from the engines, the differences included some strengthening of the undercarriage with twin wheels on the main legs and the installation of defensive armament (a tail turret).

TURBOPROP AND JET AIRLINERS AND TRANSPORTS

4

IL-18 turboprop airliner

The late 1950s were a period characterised by the emergence of several Soviet turboprop airliner designs supplementing the Tu-104 twin-turbojet airliner which had begun scheduled services in 1956. One of them was the IL-18 airliner. This was the second use of the designation – its choice was presumably prompted by the desire to establish a symbolic link to the piston-engined IL-18 of 1946 which had remained a prototype. The 'second-generation' IL-18 had nothing in common with its namesake except the general arrangement, the fuselage diameter and the mission type (passenger transportation).

The IL-18 turboprop airliner occupies a special place among the progeny of the Ilyushin Design Bureau. It deserves to be called an outstanding aircraft designed and built to a high engineering standard. It brought world fame and recognition not only to Sergey V. Ilyushin's OKB-240 but to the Soviet aircraft industry as a whole. The roles filled by this remarkable aircraft included Arctic and Antarctic research, development of sparsely populated regions, the whole range of civil aviation tasks and a wide range of military duties in Soviet/Russian Air Force and Soviet/Russian Navy service. First and foremost, however, it was a civil aircraft, remaining one of the world's principal airliners for several decades.

The IL-18 saw service with airlines and air forces in various parts of the world, earning a reputation as a well-built and reliable aeroplane. Indeed, it was probably the first Soviet airliner to achieve considerable export success. In the process of selling Ilyushin aircraft to foreign customers the Soviet foreign trade organisations accumulated a wealth of experience not only in concluding sales deals but also in filling out the supporting technical documentation conforming to international standards. The advent of the IL-18 also sparked a massive development of Aeroflot's international services.

Officially, inception of the IL-18 turboprop design dates back to late 1955. On 30th December 1955 the Soviet Council of Ministers issued a directive ordering Nikolay D. Kuznetsov (head of the OKB-276 engine design bureau based in Kuibyshev, Russia) and Aleksandr G. Ivchenko (head of the OKB-478 engine design bureau in Zaporozhye, the Ukraine) to develop new turboprop engines designated NK-4 and TV-20 respectively. (The latter designation derived from *toorbovintovoy* [*dvigatel'*] – turboprop engine – proved shortlived and was soon changed to AI-20 in keeping with the common practice of designating Soviet aircraft and engines after the OKB's founder.) The same document tasked General Designer Sergey V. Ilyushin with developing a new airliner designated IL-18 around these alternative powerplants, with the implication that the best one would be selected to power the production aircraft.

Concurrently, Oleg K. Antonov's design bureau was tasked with designing an airliner around the same engines. This was actually the first case when a new commercial aircraft was developed on a competitive basis in the Soviet Union. Unlike the Tu-104, which received a proven powerplant, the engines for the Ilyushin and Antonov airliners were developed in parallel with the aircraft designed to take them.

The reason why Ilyushin and Antonov opted for turboprops was that, while turbojet engines offered high speed, turboprops (which were the latest state of the art in aero engine design in the 1950s) had a lower fuel burn. Besides, turboprop aircraft were anticipated to have better field performance. Both aircraft had their strong points: the IL-18 offered higher fuel efficiency on long routes, while the An-10 could operate from a much wider network of airfields, including unpaved airstrips, and could be easily modified into a dedicated transport aircraft (which emerged as the An-12).

On 25th May 1956 the Council of Ministers issued a follow-up directive on the IL-18 powered by four NK-4 turboprops. According to this document the aircraft was to be submitted for State acceptance trials, which would be held in parallel by the Main Directorate of the Civil Air Fleet (GU GVF) and the Soviet Air Force, in October 1957.

To this day the reason for ultimate choice of engine type for the IL-18 and An-10 (as well as for the An-8 and An-12) remains obscure. In Soviet times the appraisal of a new aircraft or weapons system by the Powers That Be was not always objective; often its fate was decided not by its design merits but by who had more political clout – the designer or his opponents pursuing their own ends. Thus, only an expert in aircraft propulsion could make an unbiased comparison of the NK-4 and AI-20; still, competitive juices ran riot. Thus, Ilyushin was quoted as saying that under no circumstances would he let engines from Zaporozhye be installed on his aircraft (the IL-18). Similarly, Antonov (whose OKB resided in Kiev, the Ukrainian capital) stated that, while the AI-20 lacked the sophistication of the NK-4, it was more rugged and reliable. It was a classic case of the 'not invented here' syndrome on both sides.

On 27th September 1955 Nikolay D. Kuznetsov called a meeting of his design

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CCCP-Л5811 (ie, SSSR-L5811), the prototype of the 'second-generation' turboprop-powered IL-18, as originally flown with large Moskva (Moscow) titles; this was the aircraft's 'popular' name which unfortunately did not catch on.

Sergey and Dmitriy Komissarov archive

IL-18 *sans suffixe* CCCP-Л5811 cruises over the city it was born in and named after. Note the streaks extending aft from the Soviet flag on the tail which were a curious feature of the prototype's colour scheme.

staff, informing them of the government orders concerning the NK-4. The people set to work with a will and the project was completed in record time – the first prototype was ready for bench testing just 96 days after the meeting. Kuznetsov succeeded in making the engine as lightweight as possible; rated at 4,000 ehp for take-off, the NK-4 had a low specific fuel consumption (SFC) and was easy to manufacture, too.

The engine completed its manufacturer's test programme and subsequently State acceptance trials without any major problems. Thereupon the NK-4 entered production at aero engine factory No.24 in Kuibyshev (now renamed back to Samara). However, production was unexpectedly terminated after more than 200 engines had been delivered. Shortly afterwards at an MAP board meeting someone suggested making a performance comparison of the NK-4 and AI-20. OKB-478 chief Aleksandr G. Ivchenko brushed off the idea, saying this was pointless; the NK-4 was out of production anyway whereas the AI-20 was in production, so there was 'nothing to discuss', as he put it. Another engine designer, the renowned Academician Vladimir Ya. Klimov who specialised in fighter engines, was next to take the floor and spoke up in defence of Kuznetsov's engine. 'There *is* room for discussion here – he said – The NK-4 is 200 kg [440 lb] lighter than the AI-20 and has a much lower SFC. In its concept the NK-4 is an engine of the future, while the AI-20 could easily have been designed ten years ago.' Yet Klimov did not succeed in tipping the scales in favour of Kuznetsov's engine; nor did Ilyushin himself, even though he said more than once that the NK-4 was better suited for the IL-18 than the AI-20.

The Ilyushin OKB had started work on a new large long-range airliner back in 1954 – ahead of the government directives to this effect, as was often the case. The work proceeded quickly, as the engineers put the experience gained with the piston-engined 'first-generation' IL-18 to good use. While the general trend in the Soviet Union those days was that new civil aircraft should be easily adaptable for military roles, the General Designer succeeded in convincing the government that the IL-18 should be an uncompromised airliner utilising the classic low-wing layout with a circular-section fuselage and a conventional tail unit which made it possible to create a highly efficient aircraft. At a very early design stage Sergey V. Ilyushin set an efficiency target for his team – or rather what might be called an affordability target: the price of a ticket on a flight aboard the IL-18 should be on a par with a train ticket for a sleeping car. This target was met in the long run.

IL-18 prototype

On 26th August 1956 the General Designer endorsed the advanced development project (ADP) of the IL-18. Construction of the prototype began in September at MMZ No.240 (the OKB's experimental plant) located on the west side of Moscow's Central airfield named after Mikhail V. Frunze. (In passing, it may be noted that the field – better known as Moscow-Khodynka – is located in a heavily populated area some 6.75 km (4.2 miles) from the Kremlin.) In so doing the plant received assistance from MMZ No.30 'Znamya Trooda', the production factory located at the east end of Khodynka which had a long association with the Ilyushin OKB and was then producing IL-14s. At this point the NK-4 was already undergoing flight tests on a Tu-4LL testbed, whereas the competing AI-20 did not yet even exist in hardware form.

The IL-18 was of all-metal construction. The choice of the low-wing layout with conventional tail surfaces was dictated by the need to ensure maximum flight safety while keeping seat-mile costs and fuel burn down. The engineers paid special attention to the wing aerodynamics. In contrast to the swept-wing Tu-114, the IL-18 featured conventional straight wings of trapezoidal planform with an aspect ratio of 10 and a taper of 3. The wings' aerodynamic layout assured the aircraft a high cruising speed by the day's standards, as well as good stability at low speed and high angles of attack. The stabilisers were likewise of trapezoidal planform, while the fin featured moderate leading-edge sweep and an unswept trailing edge. The general arrangement and aerodynamic features of the IL-18 were optimised for high performance.

The engines were housed in four slender nacelles adhering to the wings' upper surface; the inboard nacelles also accommodated the main landing gear units. The required engine power was calculated in such a way as to make sure that enough power would be available to continue flight with one or two engines inoperative. In particular, the aircraft was to be able to continue take-off in the event of an engine failure or maintain cruise altitude with one engine dead with virtually no reduction in range. With two dead engines the IL-18 was required to continue level flight at lower altitude and speed, with a slight reduction in range. An electromechanical feathering system was developed, allowing the variable-pitch propellers to be feathered automatically or manually throughout the flight envelope, precluding the possibility of windmilling – a mode in which the propeller of a dead engine creates tremendous drag, which may cause loss of control. A go-around (that is, aborting a landing approach) was possible at any moment with all four engines running or down to 50 m (165 ft) with one or two dead engines.

The IL-18 featured a pressurised fuselage, offering comfortable conditions for the passengers and crew throughout the altitude range; the pressurisation and air conditioning system used engine bleed air. Since the pressure differential at high altitude meant the fuselage structure would be subjected to recurring loads applied from within, the fuselage had to be designed in such a way as to ensure adequate fatigue strength.

Unlike the 'first-generation' IL-18, all three landing gear units retracted forward, the nose gear being housed outside the pressure cabin. In order to reduce runway loading the main units featured four-wheel bogies; these rotated through 90° (with the forward pair of wheels uppermost) before the struts retracted so that the bogies lay inverted beneath the inboard engines.

For safety's sake the engineers of OKB-240 introduced a number of completely new features into the IL-18's design and evolved methods of testing the complete fuselage and its components for fatigue resistance. The most important of these features were as follows. To minimise the consequences in the event of an engine fire the engines were mounted ahead of the wing leading edge, the jetpipes passing over the wings all the way to the trailing edge (as a bonus, the latter feature made it possible to use the engines' residual thrust to the full). All hot components of the powerplant, including the jetpipes, were separated from the airframe by firewalls made of titanium steel. The engine nacelles were designed to provide efficient ram air cooling of the engines and equipped with a powerful fire extinguishing system utilising a highly effective extinguishing agent.

All of the principal airframe subassemblies featured structural elements increasing their resistance to long-term recurrent loads; some of these elements were duplicated for extra reliability. Thus in designing the IL-18 Soviet engineers acquired their first experience with fail-safe structures.

Another 'first' in Soviet airliner design was the provision of a weather radar in the fuselage nose. Apart from storm fronts, it could detect other air traffic and obstacles ahead and perform some navigation tasks. Hence the 'IL-18 Jr.' had a conventional nose profile with a stepped windscreen. This was obtained by simply grafting a 'thimble' onto the parabolic front end of the pressure cabin, the unpressurised structure accommodating the radar and the nosewheel well. This 'nose job' resulted in a prominent crease curving down and aft from the windshield – a fact which the Western press did not wait to mock at, commenting on the IL-18's *'unsophisticated aerodynamics'*.

The comprehensive flight instrumentation and navigation suite enabled the IL-18 to operate at night and in adverse weather conditions. This was the first Soviet airliner to have automatic landing approach capability, which further enhanced flight safety and extended the aircraft's operational envelope. The automatic approach system was built around the flight director system and autopilot; proving its worth in operation; it paved the way for a fully-fledged automatic landing system later fitted to other aircraft in Aeroflot service.

The electric system had a multi-channel layout and four-channel connection of the equipment to the distribution buses. This guaranteed that the equipment remained operational as long as at least one generator was serviceable.

A reliable and effective de-icing system permitted operation in icing conditions. Electric de-icing was provided for the wing and tail unit leading edges, propeller blades and spinners, engine air intakes, air conditioning system heat exchangers, pitot heads and flightdeck glazing.

The powerful high-lift devices gave the IL-18 good field performance, enabling it to use short runways – which may be inevitable if the aircraft has to make a refuelling stop on a long flight. The wheels were equipped with relatively low-pressure tyres, making operation from suitably prepared grass and dirt strips possible – in theory at least.

The high economic efficiency of the IL-18 anticipated by its creators was proved time and again by the type's long and successful operational career. The main criterion for assessing the aircraft's efficiency was the load ratio, the payload making up 46-49% of the take-off weight. This impressive figure was attained thanks to the rationally designed airframe structure, the use of new structural materials and advanced design and calculation methods. As a result, the IL-18's direct operating costs (DOC) were lower compared to other turboprop airliners in the same 'weight category', which was due not only to the high load ratio but also to the aircraft's good aerodynamics, powerful engines and high maintainability reducing the IL-18's fly-away price, repair and maintenance costs.

The IL-18 offered a level of comfort comparable in a number of respects to that of many airliners designed much later. The air conditioning system maintained a cabin temperature of +20°C (+68°F) throughout the flight, regardless of the altitude and the season. Sea level pressure was maintained automatically up to 5,200 m (about 17,000 ft); at a flight level of 8,000 m (16,250 ft) the cabin pressure was equal to that at 1,500 m (about 4,900 ft) above sea level, and at 10,000 m (32,800 ft) the cabin pressure equalled 2,400 m (7,875 ft) ASL. The air in the cabins was exchanged completely in less than two minutes. The overhead baggage racks incorporated passenger service units (PSUs) with individual ventilation nozzles and reading lights. The comfortable seats featured reclining backs; a lunch tray made of polished wood was stowed in a pocket on the back of the seat in front to be mounted on the armrests when lunch was served.

Two entry doors were provided on the port side fore and aft of the wings, allowing passengers to board or disembark via two mobile boarding ramps at once for quicker turnarounds. The doors were of the so-called plug type, opened by pushing

Ilyushin Aviation Complex

Above: Workers of the Moscow Machinery Plant (MMZ) No.30 pose beside the IL-18 prototype at Moscow-Khodynka. Note the broken line of the crease marking the joint between the pressurised fuselage and the unpressurised extreme nose – a feature of the prototype and the IL-18A.

Ilyushin Aviation Complex

Later in its flight test programme the IL-18 prototype received Aeroflot titles replacing the earlier 'Moskva' titles and the aircraft type was indicated on the nose. Here the aircraft is seen taking off from the airfield of its birthplace, the Central Airfield named after Mikhail V. Frunze (Moscow-Khodynka).

Yefim Gordon archive

CCCP-Л5819 (ie, SSSR-L5819), the second production IL-18 (c/n 187000102), was one of the twenty aircraft representing the first production version designated IL-18A. Like the prototype, it carried Moskva titles initially (albeit in a different typeface) and featured streaks aft of the Soviet flag. Note the extreme fore and aft position of the entry doors.

inwards and sliding towards the nose (forward door) or the tail (rear door); thus the excess pressure in the cabin held the doors firmly shut in flight.

To provide catering in accordance with internationally accepted standards the IL-18 featured a galley, as well as coat closets and well-appointed toilets. The galley was located amidships, separating the two cabins which seated 10 and 65 passengers respectively. The baggage was stowed in two compartments under the cabin floor and a third, unpressurised compartment in the rear fuselage, all with doors on the starboard side; the prototype also featured a baggage stowage area at the 'main deck' level immediately aft of the forward entry door. The cabin walls were lined with heat insulation/soundproofing mats; the cabin trim (wall liners, bulkheads, seat upholstery and so on) was made of locally produced materials with carefully chosen colours and decorative patterns.

The prototype of an all-new aircraft, especially an aircraft of this size and complexity, inevitably takes a lot of time to build, since it is virtually hand-made. Nevertheless, the work went right on schedule; registered CCCP-Л5811 (that is, SSSR-L5811), the aircraft was ready for rollout by June 1957. There is an old adage that 'what looks right flies right'; well, the turboprop IL-18 certainly looked right. The Ilyushin engineers succeeded in creating an elegant aeroplane with clean lines and well-chosen proportions. The aircraft had 15 cabin windows and two overwing emergency exits on each side (2 windows+3+2 exits+1+7); the entry doors were located at the extremities of the cabin (that is, fore and aft of all the windows on the port side).

After a period of ground checks the IL-18 began taxying tests and high-speed runs at Khodynka on 1st July 1957. Just three days later, on 4th July, a test crew captained by Vladimir K. Kokkinaki (the Ilyushin OKB's chief test pilot) took the airliner aloft for its maiden flight. The flight did not reveal anything untoward; the machine behaved as predicted and the performance figures measured during the first flight were close to the designers' estimates. For the initial flight test period the first prototype was equipped with a long air data boom attached directly to the radome, which was still empty.

A few days later CCCP-Л5811 left its birthplace, making a short hop from Khodynka to Moscow-Vnukovo airport located about 30 km (18.5 miles) south-west of the capital. There the prototype was formally unveiled to a Soviet government commission on 10th July together with the prototypes of two other new turboprop airliners – An-10 CCCP-У1957 (that is, SSSR-U1957; a highly unusual registration, since the code letter U was anything but official!) and Tu-114 CCCP-Л5611. This was a time when the Soviet aircraft design bureaux made a brief attempt to get away from the nondescript alphanumeric type designators, allocating popular names to newly-developed aircraft, as was customary in the West. Thus the IL-18 prototype proudly bore a large legend reading *Moskva* (Moscow), while the An-10 was inscribed *Ookraïna* (the Ukraine). Aeroflot's new flagship, the Tu-114 received the name *Rosseeya* (Russia) – though, unlike the other two aircraft, this name was not worn visibly by the prototype. (Regrettably the names proved shortlived; at any rate, the production IL-18 was never referred to as the Moskva during its service career).

On 20th July 1958 the IL-18 had its public debut when CCCP-Л5811 – again captained by Vladimir Kokkinaki – took part in the annual flypast at Moscow-Tushino airfield. Of course this did not escape the attention of foreign military attachés who always attended these public events. After this, the NATO's Air Standards Co-ordinating Committee (ASCC) allocated the reporting name *Coot* to the new Soviet airliner.

On 4th September 1958 General Designer Sergey V. Ilyushin was awarded a gold medal at the World Expo fair in Brussels for the development of a new airliner. In 1960, barely three years after the airliner's maiden flight, a group of OKB-240 engineers headed by Ilyushin received the prestigious Lenin Prize, one of the highest awards in the Soviet Union, from the government in recognition of their work on creating the IL-18.

Many publications mention that a second prototype bearing the registration CCCP-Л5812 and the c/n 187000002 was completed at MMZ No.30 in 1957. However, no documentary proof or other evidence of its existence, such as photographs, has been found to date.

IL-14 production at MMZ No.30 began winding down gradually in 1957 as the plant began preparing to build the IL-18. MMZ No.30 was the sole manufacturer of the IL-18 family, except that, as already mentioned, the prototype was built elsewhere.

True, plans were in hand to launch licence production in Czechoslovakia at the Avia factory near Prague. Moreover, this factory's engineering department was working on a radical redesign of the airliner – a 'baby IL-18' with an abbreviated fuselage, a shorter wingspan and only two AI-20 turboprops! Had this aircraft been built, it would have fitted nicely into the market niche populated today by such types as the Aérospatiale/Alenia ATR-72 or SAAB 2000. However, these plans failed to be put into effect – they fell victim to socialist planning and 'economic co-operation' between the member states of the Council for Mutual Economic Assistance (COMECON), the Eastern Bloc's equivalent of the EEC; the Avia factory's long involvement with aviation ended when the plant was reoriented towards utility vehicle production.

IL-18A medium-haul airliner

The decision to launch full-scale production was taken before the IL-18 had ever flown; this is evidenced by the fact that several production airframes were laid down at MMZ No.30 as early as the spring of 1957.

Designated IL-18A, the initial production version differed from the prototype mainly in interior layout. For one thing, the noise and vibrations generated by the powerful turboprops proved to be unexpectedly high, especially in the propellers' plane of rotation; for another, the prototype's 75 seats were not enough. Hence the rear wall of the forward cabin had to be moved forward to shift the rearmost row of seats out of the noisiest area, providing adequate comfort for the passengers. The baggage stowage area near the forward entry door gave way to additional seating and the seat pitch was

reduced, increasing the number of seats in the forward cabin from 10 to 19; similarly, higher-density seating in the rear cabin provided 70 seats instead of the prototype's 65, bringing the total capacity to 89. This, in turn, brought about changes in the cabin window arrangement.

Some sources in the Ilyushin OKB claim that the first production IL-18A (original registration possibly CCCP-Л5818, later reregistered CCCP-75634; c/n 187000101 – that is, *izdeliye* 18, MMZ No.[3]0, Batch 001, first aircraft in the batch of five) made its first flight on 26th October 1957. However, this seems doubtful; there is documentary evidence that the second production aircraft – the above-mentioned IL-18A CCCP-L5819 – was manufactured on 2nd October 1957, which automatically means it flew at least once before that date!

(Note: The Soviet civil aircraft registration system was changed in 1958. The operator designator was deleted and the CCCP-prefix was now followed by a five-digit number. Under the new system the IL-18 was allocated the 75xxx registration block.)

Despite MMZ No.30's prior experience with Ilyushin aircraft, mastering the IL-18 proved to be a major challenge for the factory – just as it would be for Aeroflot a short while later. Quite apart from the obvious difference in size (the IL-18 was twice as big as the IL-14 it replaced on the production line!), the aircraft represented a qualitatively new level in many respects. First of all, the new airliner had a huge pressure cabin occupying almost the entire fuselage; this placed high demands on manufacturing quality to make sure the fuselage structure was properly sealed. The provision of a pressure cabin, in turn, required the installation of pressurisation and air conditioning systems which were *terra incognita* for the plant (the IL-14 had only a simple cabin heater). The much more powerful engines caused much more powerful vibrations and ran on a new kind of fuel, kerosene; all of this created additional problems. Finally, the new-generation aircraft was chock-full of electric and electronic equipment and automatic systems – by the day's standards, of course.

Airframe manufacturing started in the sheet metal department where the metal was cut and supplied to the shops specialising in various airframe subassemblies. Shop 31 manufactured the outer wings, Shop 34 was responsible for the tail unit, Shop 35 for the inner wings and centre section, and Shop 37 for the fuselage. All this and other components were mated in Shop 38, the final assembly shop which was the heart of the plant.

Of course every single aircraft underwent a pre-delivery test programme, and this was where the factory's location suddenly posed a major problem. By the early 1960s Khodynka found itself right in the middle of the steadily growing city, in a built-up area some 6.75 km from the Kremlin (the official appellation 'Central airfield' was an apt one). The Mikoyan/Gurevich MiG-21 *Fishbed* fighters built by MMZ No.30 were dismantled upon completion and delivered by rail to the flight test facility at Tret'yakovo airfield in Lookhovitsy south-east of Moscow. (Flying them out of Khodynka was out of the question, both for security reasons and out of environmental concerns; imagine the din a jet fighter produces during take-off!) However, the IL-18's large size made this approach impossible, and trucking the dismantled airliners all the way to Lookhovitsy was too troublesome. Hence all IL-18s and other aircraft based on the *Coot* made their first flights from downtown Moscow, passing literally between the rooftops as they climbed out from Khodynka, winging their way to Lookhovitsy. The pre-delivery tests and official acceptance of each aircraft took place there.

The first IL-18As were powered by Kuznetsov NK-4s. However, this basically good engine was plagued by teething troubles and needed lengthy refinement. Being in acute need of new turboprop airliners, Aeroflot could not afford to wait until the NK-4 had been perfected; therefore on 15th July 1958 the Council of Ministers ruled that all IL-18s manufactured from November 1958 onwards be powered by Ivchenko AI-20s due to the NK-4's unsatisfactory service test results. All IL-18s manufactured by then were to be re-engined with AI-20s.

As already noted, it is hard to say why the AI-20 was selected over the NK-4 in the long run, but the whole affair was very probably a case of unfair play. In reality both engines were far from perfect in those days. The official story is that the Kuznetsov engine was less reliable and there were cases of compressor failure. However, the AI-20 (which allegedly did not suffer from this weakness) was prone to catching fire in the early years, which led to several fatal crashes. Also, the AI-20's time between overhauls (TBO) was initially barely a hundred hours.

When the first Ivchenko-powered IL-18s became available, Aeroflot started comparing the two engines in service. The airline's representatives had no objections against the AI-20; the engine was simple, and this fact alone was regarded as an asset.

The IL-18A put on weight as production proceeded, mainly due to the thicker fuselage skin introduced from c/n 188000203 (probably registered CCCP-75639) onwards. The empty weight of different 'As varied from 29,450 to 30,579 kg (64,925 to 67,414 lb) – a significant increase over the prototype's 28,000 kg (61,730 lb). Likewise, the maximum TOW of initial production aircraft was 58,000-59,350 kg (127,865-130,840 lb) versus the prototype's 59,000 kg (130,070 lb).

Production of the A model was brief, the final example rolling off the line in mid-1958. Official sources say IL-18A production was limited to the first four batches (c/ns 187000101 through 188000405), which equals a production run of only 20 aircraft.

Several IL-18As were delivered to the Vnukovo United Air Detachment (UAD) of the Moscow Territorial Civil Aviation Directorate (CAD) which began route proving flights in January 1958. In keeping with the usual practice the *Coots* carried freight and mail at this stage. The airliners were a mix of Kuznetsov- and Ivchenko-engined examples; selecting the best engine for the IL-18 was one of the goals of the test programme.

Intensive evaluation of the new airliner continued throughout 1958. Among other things, between 10th May and 20th August the IL-18 underwent joint trials at GK NII VVS at Chkalovskaya airbase about 30 km (18.5 miles) east of Moscow. This institution tested all new civil aircraft in those days, assessing possible military uses. The trials included 59 flights in which the airliner logged a total of 142 hours.

A new stage of the service trials began on 10th June 1958 when a mixed GKAT/

Yefim Gordon archive

An early-production IL-18B wearing the post-1958 registration CCCP-75669 (c/n 188000803?). This example is representative of the original interior layout and hence cabin window arrangement, with two windows aft of the forward entry door.

Aeroflot crew including captain Vladimir K. Kokkinaki (Ilyushin OKB) and first officer Boris A. Anopov (Aeroflot) started flying the aircraft. Mikhail S. Gol'dman was the OKB's engineer in charge at this stage of the tests.

Between 13th and 27th December 1958 the airliner successfully underwent cold-weather trials in Yakutsk, one of the coldest places in Russia, operating at ambient temperatures down to -52°C (-62°F). Eduard I. Kuznetsov, another Ilyushin OKB test pilot, headed the crew this time. 'Operation Cold Soak' continued from 15th January to 1st February 1959 when an IL-18A was used to test the propeller feathering system at low ambient temperatures in all flight modes. This part of the programme, which proceeded in Yakutsk, Irkutsk and Tiksi, was performed by captain Vladimir K. Kokkinaki and first officer Eduard I. Kuznetsov.

In 1958-59 the IL-18 demonstrated its capabilities for the first time – but far from the last time – when the third production IL-18A (CCCP-Л5820, c/n 187000103; later reregistered CCCP-75820) established a series of world speed and altitude records; these are described below.

IL-18B medium-haul airliner

As the IL-18 entered production and service trials began, the OKB strove to improve flight safety and reliability and enhance passenger comfort. Increasing the airliner's seating capacity/payload and extending range was another area of prime concern, as this would improve profitability.

These reasons logically led to the development of the first major production version, the IL-18B. This was basically a high gross weight version of the definitive Ivchenko-powered IL-18A. The payload was increased from 12 tons (26,455 lb) to 14 tons (30,865 lb); the maximum take-off weight grew accordingly to 61.2 tons (134,920 lb), requiring the wing torsion box, fuselage structure and landing gear to be reinforced. The unpressurised fuselage nose was redesigned to incorporate a larger dielectric radome, increasing the overall length by 20 cm (7⅞ in) and resulting in a 'puffier' nose when seen head-on.

Bearing the out-of-sequence registration CCCP-75473, the IL-18B prototype (c/n 188000501) took to the air on 30th September 1958; the aircraft was powered by the initial production variant of the AI-20. The new model allowed MMZ No.30 to fully master the *Coot*, and by the time the final 'Bs left the production line in December 1959 the plant was turning out four IL-18s per month.

It is reported that 65 IL-18Bs were manufactured, the last one being CCCP-75709 (c/n 189001801).

On 12th January 1959 the Ilyushin OKB, GK NII VVS and the State Civil Aviation Research Institute (GosNII GA) began joint trials of IL-18B CCCP-75666 (c/n 188000705). On 24th March a joint manufacturer's test/State acceptance trials programme got under way, in the course of which IL-18B CCCP-75673 (c/n 188000902) captained by Vladimir K. Kokkinaki was used to verify the compass system, autopilot and astrocompass.

A major milestone was achieved on 20th April 1959 when Aeroflot finally launched revenue services with the type after more than a year of evaluation. On that day a Moscow Territorial CAD IL-18B (CCCP-75674) captained by Boris A. Lakhtin, Hero of the Soviet Union, performed the Moscow/Vnukovo-1 – Adler service, while sister ship CCCP-75672 captained by A. Averkin flew from Moscow-Domodedovo to Alma-Ata.

From 11th to 19th June 1959 the IL-18B had its international debut when CCCP-75673 was displayed at the 23rd Paris Airshow. Once again the crew was headed by Ilyushin CTP Vladimir K. Kokkinaki. Back at home in Moscow, IL-18B CCCP-75644 was put on show at the VDNKh fairground (***V**ystavka* *dostizheniy* ***n**arodnovo* ***kh**oziaystva* – National Economy Achievements Exhibition) in 1959 together with Tu-104A CCCP-42394. Interestingly, both aircraft were later returned to service, giving place to a Tu-124V short-haul airliner (CCCP-45052).

As was the case with the A model, the IL-18B underwent various refinements in the course of production. Early-production 'Bs had 15 cabin windows to port (door+2+3+2 exits+1+7+door) and 17 to starboard (2+2+3+2 exits+1+7). However, soon after the type entered airline service it became obvious that the noise and vibrations created by the mighty turboprops were several times higher than the customary levels on piston-engined airliners. Quite apart from the discomfort, the OKB was evidently worried about fatigue life: the constant vibrations could affect the fuselage's strength in the area of the propellers. Anyway, the interior layout of the forward fuselage was changed again.

Novosti Press Agency

Busy scene at Moscow/Vnukovo-1 as a late-standard IL-18B with one window aft of the forward entry door taxies in, with An-10s, Tu-104As and more IL-18s in the background. This colour scheme was standard for Aeroflot's *Coots* until the mid-1970s.

Ilyushin Aviation Complex

A beautiful air-to-air study of an IL-18B (possibly CCCP-75690; c/n 189001205?) as it cruises over cumulus clouds. The IL-18 is an elegant airliner.

Outwardly the updated aircraft differed in having one window less on each side – that is, door+1+3+2 exits+1+7+door on the port side and 2+1+3+2 exits+1+7 to starboard. It is not known for certain when the change was made, but Batch 12 appears most likely.

Most of the already existing IL-18Bs were modified by sealing the appropriate (or rather inappropriate!) windows with metal plugs. Later, when these aircraft were due for an overhaul, the offending windows were removed altogether and the stringers and solid skin panels in the area were reinstated to bring the aircraft up to late IL-18B standard. Some IL-18As underwent a similar conversion, too.

An IL-18B with the out-of-sequence registration CCCP-75699 (c/n 189001402) manufactured on 31st August 1959 was the first example to be powered by improved AI-20 Srs 2 engines. Some sources claim, though, that the first aircraft to receive AI-20 Srs 2 engines was the first IL-18B delivered to China (registered 202, later amended to B-202; c/n 189001401). While having the same ratings as the original AI-20 Srs 1 – 4,000 ehp for take-off, a nominal power rating of 3,400 ehp at sea level and 2,800 ehp at 8,000 m (26,250 ft), – the new version featured improved reliability. Previously manufactured IL-18s were refitted with AI-20 Srs 2s in due course.

The 'B was also the first variant to be exported. The first-ever export delivery of a *Coot* took place on 21st November 1959 when the abovementioned IL-18B registered 202 was handed over to the Civil Aviation Administration of China (CAAC). In addition to China (which bought three 'Bs), two IL-18Bs were delivered to the Czechoslovak flag carrier ČSA Československé Aerolinie.

IL-18S VIP aircraft

The IL-18S ([*samo**lyot***-] ***s**alon* – VIP aircraft) was developed as a VIP version of the IL-18B pursuant to a GKAT order dated 16th May 1958. At least two such aircraft were operated by the Soviet Air Force in an airline-style colour scheme with a 'lightning bolt' cheatline different from the pre-1973 Aeroflot IL-18 standard (until the mid-1970s, each type operated by the Soviet airline had its own colour scheme). The first aircraft, serialled '001 Red' (presumably ex-CCCP-75667; c/n 189000801), was an early-production IL-18B with 15 cabin windows to port and 17 to starboard. Marshal Andrey A. Grechko, the then Defence Minister of the Soviet Union, used this aircraft during his travels around the country.

The ministerial aircraft status and the serial '001 Red' later passed to a Tu-104V VIP jet. As for the IL-18S, it received a non-standard civil registration, CCCP-33569 (actually its former radio callsign); this enabled it to fly abroad, including nations which would not allow a Soviet military aircraft to enter their airspace. Still later this aircraft was reregistered CCCP-75479.

The other known Soviet Air Force IL-18S was quasi-civil and based on a late-production IL-18B with 14 cabin windows to port and 16 to starboard (c/n 189001603?). It had the out-of-sequence registration CCCP-75749 but probably wore overt military markings before that.

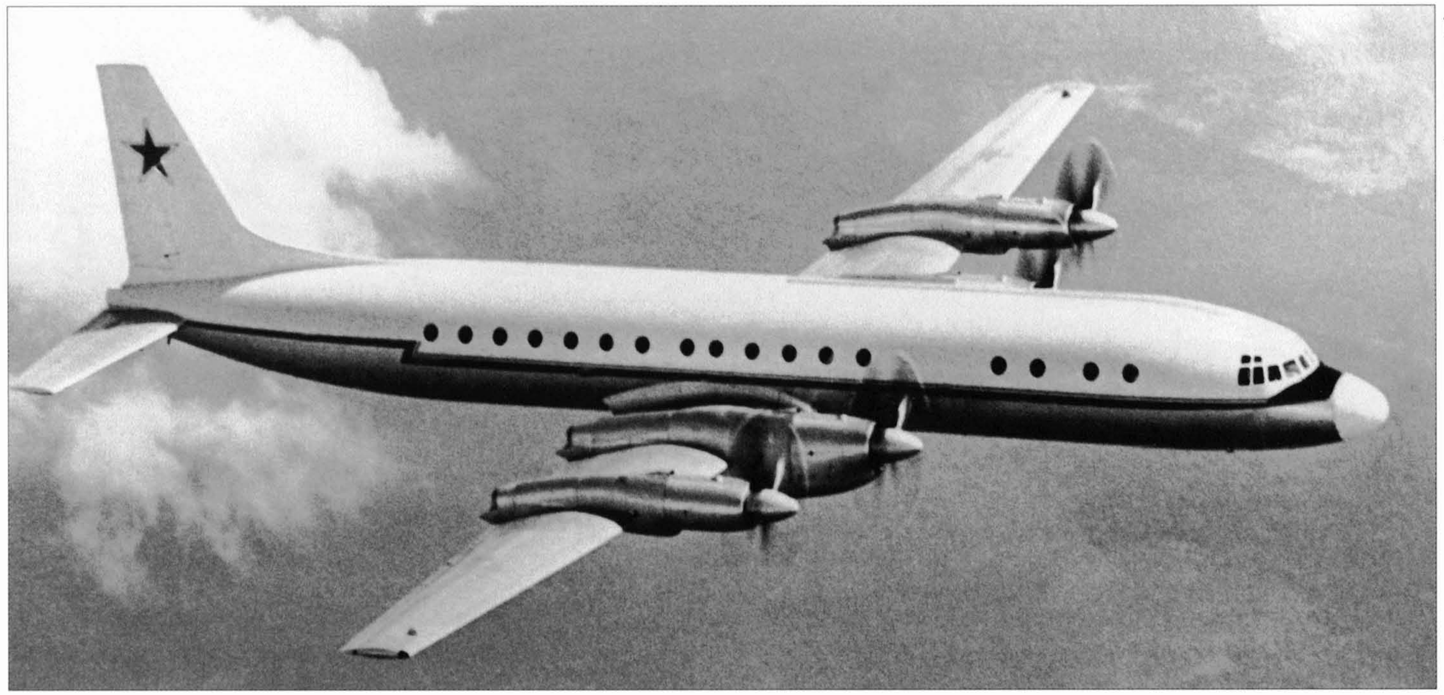
At least one IL-18S (CCCP-75705, c/n 189001702) belonged to Aeroflot's VIP unit – the 235th Independent Air Detachment (IAD) catering for the Soviet federal government. Unfortunately this aircraft crashed fatally near Kiev on 17th August 1960 after an in-flight engine fire.

IL-18V medium-haul airliner

Operational experience accumulated with the first two production models led the Ilyushin OKB to develop a further refined version of the airliner. In Russian alphabetical sequence the new model was designated IL-18V.

Interestingly, it was quite some time before the suffix letters to the designation were introduced on the *Coot* – and it was exactly the IL-18V that 'kicked off' this practice by being sufficiently different from the preceding versions. Fact is, apart from the initial variations on the engine theme before the AI-20 was standardised, the early IL-18s featured only minor alterations between the versions or within the version. These mostly concerned the fuselage, being limited to some local reinforcement, moving the interior partitions to change the size of the cabins and galley, changing the number of toilets and adding or deleting a window or two. This may explain the fact that initially neither Aeroflot nor the manufacturing plant, nor even the Ilyushin OKB discerned between the versions in their official correspondence, referring to the aircraft simply as 'IL-18'. Even when the IL-18V appeared, the earlier versions were still referred to as 'IL-18 (interior layout 17A)'. And, in fact, the IL-18V itself was initially known as the 'IL-18 (interior layout 15A)' before the suffix letters became widespread. (In passing, it may be noted that the type was invariably painted on the actual aircraft as 'IL-18' (with no suffix letter); not until the 1990s did some airlines apply the correct nose titles to a few aircraft.

While being structurally identical to that of the IL-18A/B, the IL-18V's fuselage was redesigned to allow greater freedom of interior layout, permitting the separation of the



Ilyushin Aviation Complex

Above: Several IL-18S VIP aircraft were delivered to the Soviet Air Force, wearing overt military markings and an unusual 'lightning bolt' cheatline. This example is seen during pre-delivery tests, hence the absence of a serial.

cabin into different classes, and improve passenger comfort. Unlike previous versions, the IL-18V had three completely separate passenger cabins – one at the front between fuselage frames 6-14, one in the centre fuselage (frames 22-42) and one at the rear (frames 47-54). The entry vestibules were now located in between, not at the extremities of the cabin. The toilet immediately ahead of the forward cabin section on the IL-18A/B was eliminated – most of the passengers now had to use the two toilets on the starboard side of the forward vestibule, with a coat closet in between. A second 'cloakroom' was located on the port side just aft of the forward entry door, together with rescue equipment stowage.

The galley was relocated from the area near the wing leading edge (in the propellers' plane of rotation) to the rear vestibule, much to the joy of the flight attendants. Previously the poor stewardesses were forced to spend most of the time in the area where the noise level was at its highest, exceeding 110 dB in some flight modes. The area of the galley was increased and the equipment fit became more comprehensive; another welcome change was the addition of a window in the galley compartment allowing the flight attendants to work in daylight conditions. The passengers in the rearmost cabin enjoyed the convenience of a separate compartment between frames 54-56 which accommodated a coat closet (to port) and a toilet (to starboard).

These changes resulted in a totally new window arrangement with 15 windows to port (3+door+2+2 exits+1+4+door+3) and 16 to starboard (3+2+2 exits+1+4+1+3). This arrangement was to remain almost unchanged until the end of production. The location of the door tracks also changed: the forward door now slid rearwards when opened and the rear door forwards.

Some minor changes were made to the pressurisation and air conditioning system. The IL-18V prototype with the out-of-sequence registration CCCP-75710 (c/n 189001302) entered flight test on 10th December 1959. Production of the new model began with CCCP-75711 (c/n 189001802). The IL-18V remained in production until December 1965 and a total of 334 were built in various configurations, making it the most widespread version.

Boris Vdovenko

An in-service IL-18S serialled '001 Red' (ATC callsign CCCP-33569, c/n 188000801) in the same 'lightning bolt' colour scheme. This was the aircraft of Marshal Andrey A. Grechko, the then Minister of Defence.

Initially the IL-18V was a 78-seater, the three cabins accommodating twenty, fifty and eight passengers respectively. The forward and centre cabins had five-abreast tourist class seating (2+3 with an aisle offset to port) at 90 cm (35½ in) pitch. The rear cabin, however, was conceived as a first class cabin with two rows of four-abreast sleeperette seats at 112 cm (44 in) pitch; the seats featured reclining backs and extendable leg rests. However, a report summing up the checkout tests of an early-production IL-18V, CCCP-75713, killed off the idea. *'An aircraft with such an interior layout is unacceptable as a mass-produced aircraft serving domestic routes in the USSR because Aeroflot has common fares and the tickets are not subdivided into first-, second- and third-class tickets as far as prices are concerned* – the report went – *Therefore it is considered advisable to manufacture the IL-18V in an 84-seat all-tourist configuration, which will improve operating economics.'* (this means 20+50+14 seats – that is, two rows five-abreast and one row four-abreast in the rear cabin).

Commenting on the first-class sleeperette seats, the report said, *'Despite the advantages they offer, using the seats creates a number of inconveniences; the extendable leg rest is too short, [...] when*

Yefim Gordon archive

An IL-18V belonging to the East German airline Interflug starts up its engines. The picture was taken after 1963 but before the introduction of grey fuselage undersurfaces and wings which are still unpainted.

the seat back is tilted it may injure the legs of the passenger sitting in the seat behind. The leg rest locking mechanism is troublesome and unsafe; these mechanisms were out of order on almost all seats during the one-month period of operation.' Isn't that typical of the Soviet industry (not just aircraft industry) which could make a basically good product but show complete disregard for the details – and it's exactly the minor but irritating things that can drive you up the wall.

The report was duly considered, and from then on there were no more first class seats on Soviet airliners. On the other hand, there could be no doubt that the rear cabin of the IL-18V offered the greatest comfort as far as noise and vibrations were concerned – a fact which was later taken into account when developing VIP versions for government use.

Nevertheless, the factory continued turning out IL-18Vs with the controversial clumsy sleeperette seats in the rear cabin for a while, and this mixed-class configuration was in use until Aeroflot set about increasing revenues from its IL-18 operations. The seat pitch in the centre cabin was reduced to 84 cm (33 in) to provide room for an eleventh row of seats; the rear cabin was reconfigured to feature three rows of ordinary tourist class seats – two rows five-abreast and a row of four seats (2+2) at the rear where the fuselage started narrowing. The first aircraft to be so configured was c/n 181003803 (presumably registered CCCP-75779), and most IL-18Vs were built and operated in this 89-seat layout.

Unlike the cabins, the three baggage compartments remained unchanged. Operational experience accumulated with the IL-18A/B made it possible to assess them objectively. The *Coot*'s baggage compartments were better equipped than those of the Tu-104A and An-10; however, the baggage loading doors were rather too small, allowing only very compact items to be carried. The abovementioned report concerning IL-18V CCCP-75713 No.1 stated that the baggage doors needed to be enlarged; yet this deficiency was never corrected – the size of the doors remained unaltered until the end of IL-18 production. To make matters worse the doors of the two underfloor baggage compartments opened inwards and upwards, rendering part of the floor area unusable. Nothing could be done about it at the time – the Soviet aircraft engineers had not yet figured out how to design a pressure door that did not eat up part of the baggage space.

Whereas longer range and higher capacity were the Ilyushin OKB's 'strategic' goals with respect to the IL-18 (which were attained by developing other versions described here), the more down-to-earth everyday work centred on enhancing passenger comfort and improving the avionics suite. Of course, the OKB also paid due attention to refining various structural components and systems – a natural process for an aircraft which has been in production for years.

Meanwhile, the aircraft industry took great pains to improve the reliability of the AI-20 engine which was alarmingly low at first. As noted earlier, the refined AI-20 Srs 2 was introduced from Batch 14 onwards in August 1959 when the IL-18B was still in production. Soon afterwards, in mid-1960, this engine gave way to the identically rated AI-20A (aka AI-20 Srs 3) incorporating further improvements; IL-18V DM-STB (c/n 180002001), the second example delivered to the East German airline Interflug, was the first to feature the new engines.

While the basic airframe design remained the same, subtle changes were introduced in almost every production batch in order to eliminate design shortcomings and manufacturing defects as they cropped up. Better flight instruments, new systems components and improved parts found their way to the production line. Since these modifications could affect performance and handling (usually adversely, because aircraft tend to put on weight!), a single aircraft – known as an *etalon* (standard-setter) – was picked each year for checkout trials to see if the updated IL-18 still met the specifications. Known examples are the aforementioned CCCP-75713 No.1 (c/n 180001804) which was the *etalon* of 1960, an IL-18V with the registration CCCP-75842 (c/n 182005201) which was the *etalon* of 1962 and IL-18V CCCP-75523 (c/n 183006801) which was the *etalon* of 1963.

IL-18V CCCP-75745 (c/n 181003001) manufactured on 18th April 1961 introduced an important feature – a TG-16 auxiliary power unit (APU) for self-contained engine starting and ground power supply (TG = *toorbogenerahtor* – lit. 'turbo generator'). Previously all IL-18s were provided with a

Sergey and Dmitriy Komissarov collection

Algerian Government IL-18V 'Salon' 7T-VRA (c/n 181003402) with appropriate 'République Algérienne' titles at London-Gatwick in the late 1960s.

bank of silver-zinc or lead-acid DC batteries for use as a ground power source. Developed by the Kazan' Machinery Design Bureau, now the Aviamotor Joint-Stock Co.), the APU was installed in the unpressurised rear baggage compartment; the exhaust was located just ahead of the starboard stabiliser and surrounded by a heat-resistant steel plate to protect the fuselage skin. On some aircraft the door of the rear baggage compartment featured a prominent 'elephant's ear' air intake allowing the APU to run in flight.

IL-18V CCCP-75881 (c/n 183006104) manufactured on 24th April 1963 featured a revised interior layout with high-density seating for 110 passengers (24+72+14). In 1966 the Ministry of Civil Aviation's aircraft overhaul plant No.402 at Moscow-Bykovo airport refitted IL-18V CCCP-75506 (c/n 183006404) with a 100-seat interior. The aircraft completed its trials programme on 16th December 1966, and most IL-18Vs undergoing refurbishment were progressively upgraded to this standard.

CCCP-75506 manufactured on 31st July 1963 was noteworthy in one more respect – it was the first *Coot* to be powered by the new AI-20K (AI-20 Srs 5) engines. IL-18V CCCP-75559 (c/n 184007703) manufactured on 15th October 1964 introduced an electro-pulse de-icing system.

IL-18V/VIP version (IL-18V 'Salon')

A VIP transport version of the IL-18V for government and military use was developed concurrently with the standard passenger version as a successor to the IL-18S. No separate designation is known (with a separate suffix letter, that is); however, some sources suggest the aircraft was designated IL-18V 'Salon', as simple as that.

At least 24 IL-18Vs were built as VIP aircraft. In addition to examples in Soviet service, IL-18V 'Salons' were also delivered to the Algerian Government, the Chinese People's Liberation Army Air Force, the Czechoslovak Federal Government Flight, the East German Air Force, the Polish Air Force, and the North Vietnamese Government. Outwardly the VIP version was usually identical to any ordinary 'V.

IL-18V/polar version

The need to ensure rapid resupply of, and personnel rotation at, Soviet Antarctic research stations led the Ilyushin OKB to modify a single IL-18V (CCCP-75743, c/n 181002901) for the task. This one-off aircraft featured additional long-range fuel tanks. Because of the longer endurance (necessitated by the long overwater legs of the route to the Antarctica) the engines' oil supply was also increased; the new oil tanks were too large to fit under the standard cowlings, and a large bulge had to be made on the port side of each engine nacelle over the oil tank.

Further changes included the installation of additional radio navigation and celestial navigation equipment – a fact revealed by the additional aerials and a star tracker for the astrosextant mounted in line with the second cabin window (fuselage frames 9-10), slightly offset to starboard. An angular fairing of unknown purpose was installed ventrally just ahead of the forward entry door; two tandem sets of dipole aerials for radio altimeters were fitted immediately aft of the nose gear and ahead of the wing trailing edge. The port forward emergency exit had a 'solid' (windowless) cover.

Originally the aircraft had a standard colour scheme except for the addition of small '*Polyarnaya aviahtsiya*' (Polar Aviation) titles on the forward fuselage augmenting the usual Aeroflot titles and winged logo. Later, however, the outer wings, tail surfaces and the top of the fuselage were painted Dayglo red for high definition against snow and ice in the event of a forced landing.

The aircraft flew a successful resupply mission from Moscow to Ice Station Mirnyy between 15th December 1961 and 2nd February 1962.

IL-18V-26A polar supply aircraft (IL-18D – first use of designation)

The success of the Antarctic mission of 1961-62 led the Ilyushin OKB to develop another special version of the *Coot* designated IL-18V-26A. According to some sources, the aircraft was also called IL-18D (***dahl'niy***, long-range), a designation reused two years later for another version.

To increase range a large auxiliary fuel tank was installed in the fuselage above the wing centre section, blocking up the centre cabin completely and rendering the overwing emergency exits unusable. Thus the aircraft had four separate cabins, Nos 1 and 2 being accessible only via the forward door and Nos 3 and 4 via the rear door. The non-functional emergency exits were closed by windowless covers, reducing the number of windows to 13 on the port side (3+door+2+1+4+door+3) and 14 to starboard (3+2+1+4+1+3). A star tracker was installed in line with the second cabin window but offset to port, not to starboard. Another external identification feature was the bulges on the port side of all four engine nacelles over enlarged oil tanks, just as had been the case with IL-18V CCCP-75743.

Five IL-18Vs (CCCP-75844 through CCCP-75848, c/ns 182005304, 182005305 and 182005401 through 182005403) were completed to this standard. Between 20th November 1963 and 11th January 1964 CCCP-75845 participated in the second IL-18 mission to Antarctica.

Subsequently all five IL-18V-26As were converted to standard IL-18Vs by removing the extra tank and reinstating the emergency exits. They served on with various Aeroflot divisions until finally retired as time-expired.

IL-18V calibrator version

In 1978 one of the IL-18Vs operated by the East German airline Interflug (DM-STP, c/n 184007401) was transferred from the regular transport department (IF/VF – *Interflug Verkehrsflug*) to the Inspectorate of Air Traffic Control & Communication (IF/TP-FSNW – *Interflug Technische Prüfung – Flugsicherung und Nachrichtenwesen*) and converted for the navaids calibration role. The modified aircraft featured two additional 'hockey stick' aerials mounted dorsally just aft of the forward entry door and ventrally just aft of the rear entry door; there was also an additional retractable light for phototheodolite measurements. The chief identification feature, however, was the overall grey colour scheme with a red-tipped radome and a red band around the fuselage near the No.3 baggage compartment door; this promptly earned DM-STP the sobriquet *Graue Maus* (Grey Mouse)!

The aircraft served as a calibrator long enough to see the change of East Germany's registration prefix from DM- to DDR- in 1981 and even German reunification in 1990 when it became D-AOAQ. Soon afterwards it was reconverted to standard passenger configuration.

IL-18 cargo aircraft (IL-18G?)

Any IL-18 could be adapted for carrying cargo by the simple expedient of removing the passenger seats. Right from the start the seat modules were designed to be attached to the rails in the cabin floor by quick-release fasteners, and removing the seats took no more than 30 or 40 minutes. After that, the cabins could be filled with items which were small enough to go through the entry doors. This is exactly how the IL-18A was operated by the Vnukovo UAD during route proving flights.

Besides the absence of a large cargo door (which was not developed until much later), this simple adaptation of the IL-18 for the cargo role was handicapped by the absence of any kind of cargo handling and restraining devices. Also, the absolutely superfluous cabin partitions, toilets and the like remained, eating up part of the cargo space. Some sources quoted the designation IL-18G for such makeshift freighters; the G was not simply the next letter in the Russian alphabetical sequence but denoted *groozovoy* (cargo, used attributively). However, this is unconfirmed.

IL-18T cargo/troopship/medevac aircraft (IL-18AT, IL-18BT, IL-18VT)

When MMZ No.30 had manufactured a substantial number of IL-18s, the OKB devised a way of substantially expanding the applications of these aircraft without resorting to major design changes. The result was a cargo version which could be converted from any IL-18, regardless of the original variant, in such a way as to eliminate the shortcomings of the IL-18G described above.

There was also another aspect to the matter. It is an open secret that in the Soviet Union even the overtly civilian aircraft, such as the IL-18, were designed to meet the requirements of the military as well as those of Aeroflot. As already mentioned, one of the first production IL-18s was handed over to GK NII VVS for investigating possible military uses; the development of the cargo version offered some opportunities in this respect.

Thus, as early as 18th December 1958 the Soviet Council of Ministers issued a directive ordering the development of a military transport/casualty evacuation version designated IL-18T (***trahns****portnyy* – transport, used attributively). In medevac configuration the aircraft was to carry 69 stretcher patients and two medical attendants, while the paradrop configuration was to take 118 assault troopers and two instructors.

Depending on the original version (IL-18A/IL-18B/IL-18V), the new cargo variant was initially called IL-18AT, IL-18BT or IL-18VT respectively; later the designation was shortened to IL-18T (just like in the CofM directive) for simplicity's sake. Unlike the IL-18G, the conversion involved reinforcing the cabin floor and deleting the cabin partitions, toilets and galley. To distribute the loads more evenly special inverted-U shaped frames were attached to the fuselage structure inside the cabin; these carried an overhead rail running the full length of the cabin on which an electric hoist travelled. The OKB devised special cargo pallets for the IL-18T to ease loading and unloading; when empty they were stored in the former entry vestibules. The pallets were placed near the doors, one by one, and then whisked away to the cabin by the overhead hoist as they filled up; the process was reversed during unloading. This feature saved the ground personnel a lot of legwork when working with small items of goods.

The efficiency of cargo aircraft operations depends heavily on that of cargo handling operations, and that in turn hinges on having the right equipment. Major airports have fork lift trucks and belt conveyors to ensure speedy loading and unloading, but

Yefim Gordon archive

IL-18V CCCP-75743 (c/n 181002901) was specially modified for long-range flights to Antarctica. It is seen here in its original colour scheme with additional *Polyarnaya aviatsiya* (Polar aviation) titles. Note the bulges on the port side of the engine nacelles over enlarged oil tanks.

at smaller and ill-equipped locations the process could take hours. Hence the Ilyushin OKB developed a special foldaway belt conveyor loader for the IL-18T; it was used for moving cargo from ground level or a truck bed to the door sill and stowed in the forward underfloor baggage compartment when not in use.

These measures cured many problems handicapping the so-called IL-18G, but at the expense of the latter's quick-change capability. Worse, the greatest deficiency – the inability to swallow bulky cargoes – was not overcome until many years later when the IL-18 had almost vanished (see IL-18GrM); the IL-18T could only carry small packages.

The IL-18T was also suitable for troop transportation (but not for paradropping – this capability took several more years to incorporate). In this configuration the overhead cargo hoist was removed and longitudinal beams were attached to the vertical load distribution frames. These carried rigid seats installed along the fuselage sides, with a third row on the centreline to give a total of 114. Each seat was provided with an oxygen mask and supply hose.

For the medevac role 63 stretchers in three tiers, three-abreast, were installed on fittings attached to the transverse frames and special uprights in the cargo cabin. The passages between the rows of stretchers permitted medical attendants to tend any patient. There were two seats for the medical attendants at the front and rear of the cabin, and a doctor's table was installed in the middle row near the forward entry door.

State acceptance trials of the IL-18T prototype (identity unknown) began on 29th February 1960; the aircraft was powered by AI-20 Srs 3 (AI-20A) engines.

IL-18V mid-life updates

After the advent of the IL-18V further development of the *Coot* proceeded along two lines. One was a persistent effort to improve the V model; this was not limited to dealing with defects as they surfaced but included the introduction of such goodies as anti-collision lights, Doppler speed/drift sensors and so on. Some of these changes disrupted the clean lines of the aircraft while others removed existing excrescences, making the airliner more elegant.

The other main thrust was aimed at developing new versions that would allow the IL-18's potential to be used to the full. In so doing the Ilyushin OKB engineers were willing to resort even to significant airframe changes (which are usually avoided insofar as possible).

The powerplant (specifically, the appallingly low engine life and TBO), the troublesome (and initially incomplete) radio navigation suite and the inadequate level of passenger comfort were the IL-18's main failings at the time. Passenger comfort in this instance depended on a multitude of factors, the most important one being cabin noise; the immediate objective was to reduce the noise level at least to the 100 dB prescribed by the Soviet standards then in force. Another area requiring attention was the air conditioning and pressurisation system: it was imperative to reduce the rate at which cabin pressure changed during climb/descent so that the aircraft would be easier on the passengers' ears. It was also necessary to improve the cabin ventilation rate, reduce the content of harmful substances in the cabin air, include an air humidification feature and provide air conditioning on the ground when the engines were inoperative. Finally, there was the issue of seat design and seating arrangement.

The OKB had varying success in addressing these issues; radical improvements in some areas were interspersed with only modest results in others, and sometimes the engineers' efforts backfired. Of course, the IL-18V was not the only version to benefit from these changes – new features which proved their worth were incorporated on later versions, and some were retrofitted to earlier versions as well. It makes sense to describe the features added to the IL-18V during the production period 'in order of appearance'.

Sergey Komissarov

Seen here at Moscow/Vnukovo-1 in its days as a passenger aircraft, IL-18V CCCP-75785 (c/n 181003904) features a TG-16 auxiliary power unit introduced on Batch 30 onwards in 1961. It later became an IL-18T.

As already mentioned, a TG-16 APU was fitted as standard to all aircraft from IL-18V CCCP-75745 (c/n 181003001) onwards. Until then the only electric power source when the engines were shut down (aside from ground power units) consisted of DC batteries installed at the same location – in the unpressurised rear baggage compartment. IL-18As and most IL-18Bs featured a quartet of 15STsS-45 silver-zinc batteries; from the final IL-18B (CCCP-75709, c/n 189001801) onwards the number was increased to six for more reliable engine starting at low ambient temperatures. From Batch 23 onwards these were substituted by twenty 12SAM-28 lead-acid batteries which had a lower capacity but were cheaper. The provision of an APU allowed most of them to be deleted, which gave a significant weight saving. All previously built *Coots* were progressively retrofitted with the APU during overhauls.

Of course, the modifications were not limited to simply switching the excess batteries for the APU and cutting a hole for the exhaust ahead of the starboard tailplane. The TG-16 required a separate fuel tank (with a separate filler cap), fire extinguishing, indication and warning systems.

The avionics were updated, too, which also led to some exterior changes. Originally the IL-18 was equipped with two pairs of communications radios – two RSB-5/1230 HF radios and two RSIU-4 VHF radios (one of each model was a backup unit in case the main one failed). All four radios used a common wire aerial stretched between the flightdeck roof and the top of the fin, with a strake aerial running all the way from the flightdeck to the forward emergency exits as a backup.

The RSIU-5 VHF radio became a standard fit from Batch 39 (that is, presumably from IL-18V CCCP-75782) onwards, replacing the earlier RSIU-4; outwardly it was identifiable by an L-shaped aerial mounted ventrally in line with the third cabin window on each side. However, some earlier aircraft, including IL-18B c/n 189001502 (CCCP-75701?), were fitted with the new radio before that – probably for test purposes. Later, the main RSB-5/1230 radio was replaced by a more advanced RSB-70 HF radio.

While making his state visit to the USA in 1959, the Soviet leader Nikita S. Khrushchov noticed that American airliners were equipped with anti-collision lights – flashing red beacons making the aircraft more conspicuous during taxying and in flight. On return to Moscow he instructed the heads of Soviet aircraft design bureaux to incorporate this safety feature on Soviet airliners. Thus, starting with IL-18V CCCP-75792 (c/n 181004101), all *Coots* left the factory equipped with SMI-2 anti-collision lights atop the fin and under the aft fuselage just ahead of the fin leading edge; all existing IL-18s were progressively upgraded.

The weather radar was one particular problem area. All Soviet first-generation turbojet and turboprop airliners were designed to have radar – a totally new feature for Soviet civil aviation. However, the Tu-104 featured an RBP-1 radar which had been already put through its paces on the Tu-16 bomber (it was actually a bomb-aiming radar, hence the designation RBP for ***rah**diolokatsi**on**nyy bombardi**rov**ochnyy pri**tsel*** – 'radar bomb sight'). Conversely, the IL-18's RPSN-2 *Emb**lem**a* (Emblem) was a purely civilian weather radar (RPSN = ***rah**diolokatsi**on**nyy pri**bor** sle**poy** navi**gaht**sii* – blind navigation radar device) – and was brand-new, which inevitably meant lots of teething troubles. The first sixteen batches (c/ns 187000101 through 189001605) – that is, all IL-18As and most IL-18Bs, including all export examples – were completed without radars because the RPSN-2 was still beset with problem, even though the delivery papers accompanying the aircraft stated the radar was installed!

Not until the advent of the V model did the factory begin delivering *Coots* with the radar fitted as standard (actually the last six IL-18Bs, c/ns 189001701 through 189001801, were the first to be completed with the radar in place). Even so, the crews found the radar virtually useless at first because the thing didn't work. When IL-18V CCCP-75713 No.1 (c/n 180001804) was submitted for check-out trials in April 1960, the type had been in service for about 18 months and nearly 90 aircraft had been built. Nevertheless, the results proved unsatisfactory; the trials report read:

'The service reliability of the Emblema radar is absolutely inadequate. Radar operation was unstable throughout the trials period; as a rule, all manner of malfunctions occurred 1.5 to 2 hours after take-off and the radar failed. This is despite the fact that the radar was serviced on the ground and operated in flight by the OKB's and manufacturer's personnel, not the flight crew.

The operation of the radar is deemed unsatisfactory.'

In practice this meant that, like their colleagues flying the piston-engined IL-14s, the crews of the IL-18s were forced to rely on auxiliary radio navigation aids. The cause of the misery was soon traced to the radar set being installed outside the pressure cabin (in the 'thimble' incorporating the nosewheel well); the pressure and temperature fluctuations experienced in flight ruined the delicate electronics. Things improved radically when the 'brains' were relocated to the pressure cabin, starting with IL-18V OK-OAC (c/n 180002101) – the first 'V delivered to Czechoslovakia. IL-18Bs c/ns 189001701 and 189001703 through 189001801, IL-18S c/n 189001702 and IL-18Vs c/ns 189001802 through 180002005 were modified accordingly, and all previously built aircraft were finally retrofitted with radar.

Sergey and Dmitriy Komissarov archive

IL-18Vs on the final assembly line in Shop 38 of MMZ No.30 at Moscow-Khodynka.

It will be fair to say that by far the greatest part of the IL-18's plentiful electronics served to make the airliner suitable for adverse weather/night operations.

Apart from the temperamental avionics, another crucial factor affecting flight safety and all-weather operation capability was the operation of the de-icing system. In 1959, when the service trials were under way at Moscow-Vnukovo, IL-18As CCCP-Л5819 (c/n 187000102) and CCCP-Л5820 (c/n 187000103) were fitted with sensors and ciné cameras for assessing the efficiency of the de-icing system in various conditions. The verdict was unambiguous and distressing: 'The de-icing system fitted to the wings and tail surfaces of the IL-18 aircraft does not ensure safe operation in severe icing conditions.' The system's electric heaters were not powerful enough; however, installing more powerful heaters would require major changes to the electric system and installation of more powerful generators (which were presumably unavailable at the time). Hence the unsatisfactory system remained unaltered and the crews were told to avoid conditions when severe icing was possible.

In 1962 an IL-18 captained by Boris A. Anopov almost crashed after losing longitudinal control due to stabiliser icing. When the flaps were fully deployed for landing the horizontal tail stalled and the aircraft suddenly dropped its nose, entering a steep dive. Eleven seconds later the pilots managed to recover from the dive at only 400 m (1,310 ft). After this incident, changes were made to the stabiliser de-icers and maximum flap deflection was reduced from 40° to 30°.

The situation persisted until 1965 when GosNII GA floated an idea which cured the problem completely without requiring any design changes. Quite simply, instead of increasing the power of the heaters the engineers changed the duration of their operating cycles (heating/cooling phases). The idea was tested successfully on IL-18V CCCP-75559 (c/n 184007703) and put into fleet-wide practice.

The powerplant also gave plenty of causes for complaint – the engine makers were making slow progress in their efforts to refine the AI-20. An official document dated early 1962 read: *'On account of the positive results obtained during bench testing the service life until the first major overhaul of the AI-20 Srs 3 engine is designated as 400 hours. [...] No reclamations are accepted for AI-20 Srs 3 engines concerning combustion chamber burnout after 200 hours' total time and concerning all other malfunctions after 300 hours' total time; the engines are to be considered off-warranty at this point.'* Well, if engine life remained so ridiculously low four years after the AI-20 had entered large-scale production, the state of affairs can be characterised with one word: lousy.

It was another year before MMZ No.30 started manufacturing IL-18s powered by AI-20K (AI-20 Srs 5) engines with an initial TBO increased to 2,000 hours. The first aircraft to receive the new engines was IL-18V CCCP-75506 (c/n 183006404). The IV-41 engine vibration monitoring kit (*izme**rit**el'*

vibrahtsii) was fitted concurrently to enhance operational safety; the system had undergone rigorous testing on IL-18B c/n 188000604 (presumably CCCP-75660).

Despite its many shortcomings (quite apart from the gravest ones described above, there was a list of no fewer than 33 items which needed attention!), the IL-18V entered large-scale production; in fact, it became the most widespread variant of the *Coot*, staying in production far longer than any other version. By the end of 1961 the factory had increased the IL-18's production rate appreciably, turning out six aircraft per month instead of four. By then production of the An-10 and the Tu-104 had come to an end, leaving the IL-18 as the sole 'survivor' among the Soviet Union's first-generation turbine-engined airliners.

This was just the kind of aeroplane Aeroflot needed – more fuel-efficient and less demanding to runway length and surface quality than the Tu-104 but longer-legged than the An-10. And this is exactly why the IL-18V was the centre-stage actor for both the world's largest airline, which Aeroflot was then, and the Soviet Union's East European satellites. (In contrast, the Tu-104 achieved negligible export sales, while the An-10 was not exported at all.)

Meanwhile, after improving the efficiency of cargo operations by developing the IL-18T the Ilyushin OKB decided to tackle this noble task in the field of passenger transportation as well. This was achieved by simply increasing the number of seats to 110 – without stretching the fuselage. After the galley area had been shrunk and the sleeperette seats in the rear cabin replaced with ordinary ones, the only way to cram more passengers into the *Coot* was by further (and much more significantly) downgrading passenger comfort. The increase in seating capacity was bigger this time, but it was achieved solely by packing the luckless passengers together like sardines in a can.

The need to install six-abreast seating instead of five-abreast led to the development of new seats: the single seats used hitherto gave place to triple units. The seat backs were no longer reclining, but the armrests could be raised and the backs of the seats in front folded forward for ease of access to the window seats. The width of the aisle was decreased to 350 mm (13¾ in) – or just 280 mm (11 in) if the people in the aisle seats were keeping their elbows on the armrests. Getting past a person standing in the aisle or pushing a catering trolley along the aisle now became a real problem.

The seat pitch, too, was a mere 75 cm (29½ in); this was called the economy class. This arrangement increased the number of seats in the forward and centre cabins to 24 (four rows) and 72 (12 rows) respectively; the rear cabin was thus the most comfortable of all, retaining the 14 tourist-class seats five/four-abreast at 84 cm pitch.

As noted earlier, the high-density configuration was tested on IL-18V CCCP-75881 in the spring of 1963 and introduced in Aeroflot service shortly afterwards. The discomfort associated with this layout was tolerable during flights lasting one or two hours – especially since the 110-seater solved many problems during the summer season when thousands of holidaymakers rushed from Moscow, Leningrad and Kiev to resorts on the Crimea Peninsula and in the Caucasus. Later, however, this configuration became standard on longer flights to the Siberia and Central Asia – with the usual justification of making more money.

The larger-than-ever number of passengers exacerbated an old problem, namely the need to provide an acceptable microclimate (that is, improve ventilation and cabin air exchange), introduce air conditioning on the ground with the engines running at low rpm and, of course, reduce cabin noise levels. For three years (during which the IL-18 had been in production by then) the OKB had repeatedly tried to solve the noise problem – with scant success. Using thicker soundproofing mats, increasing the size of the ventilation system's air outlets and deleting the system's bypass valve gave little effect. In fact, the latter measure proved harmful because the air exchange rate became much worse and the carbon monoxide content in the cabin air – which was high as it was – increased further.

In late 1963 the engineers attacked the problem from another angle. Since the propellers were the main source of noise, the OKB attempted to attenuate the noise they generated by synchronising the propellers. Unusually, Ilyushin chose to use the de Havilland XQ-1120 propeller synchronisation system rather than develop a similar system in-country. The system was fitted to IL-18B CCCP-75681 (c/n 189001101); some sources claim it was tested on IL-18V CCCP-75834 (c/n 182005104), which may be true as well. The XQ-1120 system showed promising results; however, it transpired that major modifications to the AI-20's reduction gearbox and other changes would be required, and the idea was dropped.

A little earlier IL-18B CCCP-75666 (c/n 188000705) and IL-18V CCCP-75834 (c/n 182005104) underwent testing with a modified air conditioning system which allowed the cabin to be conditioned on the ground with the engines running. Once again, however, the OKB was not in a hurry to introduce this feature into mass production.

Almost a year after the trials of the 110-seat version another IL-18V, the *etalon* of 1963 (CCCP-75523, c/n 183006801), underwent rigorous testing to see if it met the specs. The result was deplorable: apart from the many complaints concerning the aircraft's avionics (primarily poor electromagnetic compatibility of various systems), the test report pointed out that noise levels were practically unchanged as compared to earlier IL-18s. The noise level peaked at 118 dB in the rear seat rows of the forward cabin and 112 dB in the front rows of the centre cabin; in the forward vestibule the noise was even louder, reaching 119 dB!

IL-18I development aircraft

21st December 1960 saw the beginning of the manufacturer's flight tests of a new version designated IL-18I or IL-18/variant 21A. The suffix letter I was not in the Russian alphabetical sequence, so chances are that it stood for *issledovatel'skiy* (research, used attributively).

Bearing the registration CCCP-75888, the IL-18I was reportedly converted from the second prototype of the *Coot* (that is, an IL-18 *sans suffixe*). However, there are reasons to doubt this because the window arrangement was similar to that of the IL-18V; since the latter model was in production by then, it would be far easier to pull an IL-18V off the assembly line for conversion.

This time the redesign was far more extensive. The aircraft could carry 119-125 passengers; the increase in seating capacity was obtained by moving the rear pressure bulkhead 1.64 m (5 ft 4½ in) aft from fuselage frame 56 to frame 62, thereby eliminating the unpressurised rear baggage compartment and the associated door between frames 58-61. (The oft-cited allegation that the IL-18I had a fuselage stretch of 1.64 m is misconception; the overall length remained unchanged.) The new interior layout caused a change in the window arrangement, with two extra windows on each side (3+door+2+2 exits+1+4+door+5 to port and 3+2+2 exits+1+4+1+5 to starboard).

Sergey and Dmitriy Komissarov archive

The IL-18I development aircraft; note the additional cabin windows on the rear fuselage.

Maximum range was extended from the IL-18V's 4,700 km (2,920 miles) to 6,500 km (4,040 miles) thanks to a 28% higher fuel capacity – total fuel was increased from 23,700 litres (5,214 Imp gal) to 30,300 litres (6,666 Imp gal). This necessitated major structural changes in the wings: two more manufacturing joints were added immediately outboard of the inner engines and the flexible fuel cells in the inner wing portions between the inner and outer engines gave place to integral tanks. Additionally, fuel cells were installed in the wing centre section which was integral with the fuselage. The fuel system comprised 26 tanks (4 integral tanks and 22 bladder tanks); refuelling was possible both under pressure and by gravity. There was no fuel jettison system.

The IL-18I was the first *Coot* to feature an auxiliary power unit. Unlike late-production IL-18Vs *et seq.*, the TG-16 APU was not installed in the rear fuselage; it was mounted under the fuselage on a special frame which swung down on parallel arms before the APU could be started. When retracted the APU was almost invisible – its presence was revealed only by a small flattened teardrop fairing immediately ahead of the wing leading edge.

The maximum take-off weight increased to 64 tons (141,090 lb) and the payload rose from 13.5 to 14 tons (from 29,760 to 30,865 lb).

The State acceptance trials of the IL-18I, which were duly completed on 14th December 1961, included several non-stop long-range flights from Moscow to Irkutsk, along the Irkutsk – Moscow – Leningrad – Moscow route, from Moscow to Tashkent via Vladivostok and Khabarovsk, and from Tashkent to Moscow via Arkhangel'sk. The flights lasted from 8 to 12 hours; all systems worked OK. The results were encouraging and, although the IL-18I was destined to remain a one-off, many of its new features were incorporated in the next major production versions superseding the V model – the IL-18E and IL-18D.

IL-18D medium/long-haul airliner (second use of designation)

In 1964 IL-18V production was drawing to a close as the Ilyushin OKB prepared to launch a new variant which was destined to be the ultimate commercial version of the *Coot*. Continuing the Cyrillic alphabetical sequence (A, B, V, G and so on), the aircraft received the designation IL-18D used earlier for the 'limited edition' IL-18V-26A. This coincidence was logical enough, since the new aircraft was designed as an extended-range version (though not specifically for Antarctic supply missions) and the explanation ***dahl'****niy* was perfectly applicable.

Dmitriy Komissarov

The Domodedovo Civil Aviation Production Association (now Domodedovo Airlines) was one of the last Russian carriers to operate the IL-18 as a passenger aircraft. Here, IL-18D RA-74268, one of the airline's last two remaining *Coots*, rests between flights at Moscow-Domodedovo on 11th November 1998. It was sold to Tyumen' Airlines shortly afterwards.

Development of the 'IL-18D Mk II' was long and arduous, as some of the features which went into this model had been under development since 1961. Also, development problems with the IL-18D caused another version, which was actually developed later and bore a higher suffix letter, to 'jump the queue' to the production line (as described in the IL-18E section below).

In 1964 Aleksey G. Ivchenko's OKB-478 was putting the finishing touches to a new uprated version of the AI-20 turboprop – the AI-20 Srs 6, aka AI-20M (*modifi****tsee****rovannyy* – modified). Now there were no more obstacles to creating – at long last – a fully-fledged long-haul version of the IL-18 where seating capacity and payload were not compromised by fuel tanks in the middle of the cabin, as was the case with the IL-18V-26A. Compared with the latter model, the prospects of the 'IL-18D Mk II' looked far more optimistic.

When the AI-20M entered series production at MAP factory No.478 (now called Motor-Sich), it was truly a milestone for Soviet civil and military transport aviation. Until then, the AI-20 had often been the subject of serious criticism – and well-deserved criticism it was. However, the advent of the AI-20M showed the people at OKB-478 had been doing their homework; the new version elicited the most favourable comments from those who had to deal with it.

To begin with, the AI-20M's take-off power was increased from 4,000 to 4,250 ehp, which not only made a long-planned gross weight increase possible but enhanced flight safety in the event of an engine failure during take-off. Also, remember that engine power drops in hot-and-high conditions; thus the new engine considerably alleviated the problems associated with serving destinations in the Soviet Union's Central Asian republics and the Caucasus, not to mention such places as Afghanistan and Ethiopia. The power increase was modest, amounting to some 7%, but it was apparent in almost all flight modes. For instance, at maximum power rating at 8,000 m (26,250 ft) the AI-20M delivered 3,420 ehp versus 3,180 ehp for the AI-20K; at nominal (that is, maximum continuous) power rating at the same altitude it was 2,980 ehp and 2,800 ehp respectively. Equally important was the fact that maximum continuous power could now be used for much longer periods, making it possible to use a more efficient flight profile (flying at the aircraft's service ceiling as long as possible to save fuel) or climb to a given flight level more quickly.

However, these are by no means all of the AI-20M's virtues. At all power settings the specific fuel consumption was reduced as compared to the AI-20K, the reduction amounting to 7% at take-off power, 5% in cruise mode at 8,000 m and 3.5% at maximum continuous power at the same altitude. Moreover, the new model was 40 kg (88 lb) lighter: the dry weight of the AI-20M was 1,040 kg (2,292 lb) versus 1,080 kg (2,380 lb) for the AI-20K! Finally, it should be noted that the AI-20M was simpler in design and more reliable, while the TBO was increased from an initial 1,000 hours to 2,000 hours in 1966, then to 3,000 hours in 1967 and finally to 4,000 hours. Needless to say that the Much-Improved M was greeted with enthusiasm!

The IL-18D was to incorporate all of the new features tested on IL-18V CCCP-75834 (c/n 182005104). Among other things, the D model was to introduce the long-expected upgrades to the air conditioning system. The forward vestibule was redesigned, allowing

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Above: Yugoslav Air Force '73201' (ex-7501, ex-YU-AIA, c/n 187009805) represented the IL-18D 'Salon' VIP version. It was later sold to Aeroflot in airline configuration as CCCP-75451 No.2 and subsequently converted into an IL-22M airborne command post for the Soviet Air Force as CCCP-75919.

the centre cabin to be extended forward; as a result, the IL-18D introduced a new window arrangement with 16 windows to port (3+door+3+2 exits+1+4+door+3) and 17 to starboard (3+3+2 exits+1+4+1+3). The extra window ahead of the overwing emergency exits was thus the IL-18D's external identification feature.

The main changes, however, were not so obvious. In addition to the new engines, the fuel capacity was enlarged considerably – this time without any drastic changes to the airframe design. The wing centre section built integrally with the fuselage housed 6,300 litres (1,386 Imp. gal.) of extra fuel; unlike the experimental IL-18I, the wing centre section torsion box functioned as an integral tank rather than accommodate a set of bladder tanks. The centre section tank (the No.23 tank) increased overall fuel capacity to 30,000 litres (6,600 Imp. gal.) and the take-off weight to 64 tons (141,090 lb), enabling the aircraft to carry a 6.5-ton (14,330-lb) payload over a distance of 6,500 km (4,040 miles) with maximum fuel, including reserves for one hour. With a maximum payload of 13.5 tons (29,760 lb) the IL-18D had a range of 3,700 km (2,300 miles) if the engines operated in cruise mode (84-85% of the maximum continuous power rating) most of the time; this operational mode was easier on the engines, as the turbine temperature was lower.

Construction of the first prototype IL-18D began in mid-1964; to this end the newly completed fuselage of IL-18V c/n 184007803 was pulled off the assembly line to make the short way to the Ilyushin OKB's experimental shop (MMZ No.240) located right across the field. As modification work progressed on the fuselage, other airframe subassemblies and components were gradually delivered from MMZ No.30 and the aircraft took shape little by little. Thus both plants – or neither plant – can claim to have to have manufactured the aircraft!

Bearing the registration CCCP-75581, the prototype entered flight test on 31st July 1964. To speed up completion of the trials a second prototype registered CCCP-75572 (c/n 185008001) was laid down in January 1965, undergoing flight tests between 26th July and 21st September that year. Even before that, on 29th January 1965, the newly-restored Ministry of Aircraft Industry (renamed back from GKAT) and the Ministry of Civil Aviation (MGA – *Mini**ster**stvo grazh**dahn**skoy aviahtsii*) had passed a joint order to the effect that the 'modified IL-18D airliner' be put into full-scale production. However, this turned out to be wishful thinking and it was some time before the aircraft could enter production (see IL-18E section below).

From 13th to 25th June 1965 IL-18D CCCP-75581 and the second prototype of the IL-62 *sans suffixe* four-turbofan long-haul airliner (CCCP-06153) had their international debut at the 26th Paris Airshow. The occasion was all the more notable because the Soviet Union had thus re-established its presence at Le Bourget after a long, long break.

On 30th May 1966 the two prototypes of the IL-18D completed their checkout trials after all development problems with the new powerplant had been overcome. The D model finally entered production in July 1966 from Batch 93 onwards, remaining the sole commercial version until production of the civil *Coot* ended (military derivatives of the IL-18 continued in production for many more years and are described separately). It was the second-largest version as far as production volumes are concerned, having a production run of 122.

Three years later came the day which everybody knew would come sooner or later – but the knowledge did not make the occasion any more festive for those concerned. On 17th April 1969 MMZ No.30 manufactured the final commercial *Coot* – an IL-18D with the c/n 189011304. (Note: Some sources give the manufacture date as 28th March 1969; thus 17th April may be the roll-out date or the first flight date.) Registered 5T-CJL, this aircraft was delivered to the Mauritanian airline Air Mauretanie, subsequently being resold to Vietnam as VN-B198. Thus commercial production of the IL-18 totalled 564 aircraft built by MMZ No.30. These aircraft formed the backbone of Aeroflot and the flag carriers of the East European nations ('the Eastern Bloc'), and the Soviet aircraft industry had good reason to be proud of these winged machines.

From 10th to 13th February 1980 IL-18D CCCP-74267 (c/n 188011105; the c/n was erroneously applied as 187011105) flew an Antarctic support mission for the Arctic & Antarctic Research Institute (AANII – ***Ark**tiko-Antark**tich**eskiy na**ooch**no-is**sled**ovatel'skiy insti**toot***), flying from Moscow-Sheremet'yevo to Ice Station Molodyozhnaya along the so-called central route via Odessa, Cairo, Aden and Maputo. Unlike IL-18V CCCP-75743 and the special IL-18V-26As, the aircraft, which wore Aeroflot's smart red/white 1973-standard Polar colours, was almost unmodified, apart from the addition of some navigation equipment (including a star tracker for the astrosextant on the flight-deck roof) – that is, there were no enlarged oil tanks and the engine cowlings were perfectly standard. The two flight crews working in shifts were captained by Yevgeniy P. Boonchin and A. N. Denisov, while overall mission co-ordination was performed by Boris D. Groobiy. The aircraft covered the 15,992-km (9,933-mile) route in 26 hours' flight time. The return journey along the same route took place during 19th-23rd February; all in all, the airliner covered a distance of 45,660 km (28,360 miles), staying airborne for 78 hours 54 minutes.

Exactly one year later, on 10th February 1981, the same aircraft took off from Leningrad-Pulkovo, bound for Ice Station Molodyozhnaya on the central route with the 26th Soviet Antarctic Expedition on board. CCCP-74267 arrived at her destination on 12th February, covering a distance of 17,190 km (10,677 miles).

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Late-production IL-18Ds on the assembly line in 1968; the nearest aircraft features an 'elephant's ear' air intake for the APU on the No.3 baggage compartment door. Note the IL-38 ASW aircraft in the background.

IL-18D/VIP version (IL-18D 'Salon')

Again, a VIP transport version of the IL-18D was developed for government flights and air forces. Once again no separate designation is known, so the VIP version is referred to here as the IL-18D 'Salon'. There were no obvious external recognition features to distinguish such an aircraft from an ordinary 'D.

Twelve IL-18D 'Salons' have been identified. In addition to Soviet customers, there were foreign recipients: Royal Afghan Air Force, Bulgarian Air Force, Chinese People's Liberation Army Air Force, East German Air Force, Romanian Government, and Yugoslav Government.

IL-18D VIP/communications relay aircraft

Long after the 235th OAO (*ot**del'**nyy **aviaotryad*** – Independent Flight Detachment), the Soviet government flight based at Moscow-Vnukovo, had stopped using the *Coot* as a VIP transport it still operated three IL-18Ds – CCCP-75453, CCCP-75454 and CCCP-75464. They were fitted out as communications relay aircraft supporting HF communication between the Kremlin and suitably equipped VIP aircraft. The comms relay IL-18Ds had the same antenna farm on the forward fuselage as the IL-18V ABCPs described below (CCCP-75602 and -75606), plus a third identical set of blade aerials located ventrally aft of the wing trailing edge.

Yuriy Kirsanov

The 235th Independent Flight Detachment (Soviet government flight) operated several IL-18Ds fitted out as communications relay aircraft. This is one of them at Moscow-Vnukovo in post-Soviet days as RA-75454 (c/n 187010104). Note the additional HF communications aerials on the forward and rear fuselage.

The mission equipment was compact and the aircraft could still be used as an airliner, carrying officials between Moscow and Leningrad. Some sources refer to this version as the IL-18RT (*retrans**lya**tor* – relay station), also described below.

The three IL-18s continued in service when the 235th IFD became the Russia State Transport Company in September 1993, remaining operational until the late 1990s.

IL-18E medium/long-haul airliner

As already mentioned, the IL-18D was ordered into production on 29th January 1965. However, the tests of the AI-20M engine (and consequently the IL-18D) looked set to become a protracted affair, and the aircraft was overdue for an upgrade in many areas. Hence the Ilyushin OKB and MAP decided to stick to the AI-20K engines and 61.2-ton (134,920-lb) take-off weight while incorporating the improvements already tested on the 122-seat IL-18V CCCP-75834 (c/n 182005104) in the autumn of 1964. In this guise the airliner would be produced until the IL-18D was deemed ripe for production.

In order to discern it from the original IL-18V the interim version was designated IL-18E (though IL-18Ye would be a more accurate rendering perhaps).

The IL-18E was unveiled at the 1965 Paris Airshow, albeit not in hardware form yet. The new version started rolling off the assembly line in September 1965. The first production IL-18E was CCCP-75592 (c/n 185008502) which first flew on 30th September and completed checkout trials on 15th December that year. Twenty-three examples were built before production finally switched to the IL-18D in 1966.

'IL-18M'

It may be mentioned here that in September and October 1965 the East German magazine Aerosport mentioned a 'further upgrade' of the *Coot* designated IL-18M. The aircraft allegedly had a reinforced wing centre section/inner wing assembly and landing gear allowing the maximum TOW to be increased by 2,000 kg (4,410 lb) and the seating capacity to 126; range with a maximum payload of 14.5 tons (31,970 lb) was stated as 1,600 km (990 miles). However, this designation was obviously erroneous, as no mention of it can be found in Soviet/Russian sources.

IL-18E/VIP version (IL-18E 'Salon')

Once again, a VIP version of the IL-18E existed; as no separate designation is known, it will be referred to as the IL-18E 'Salon'.

Seven aircraft have been identified. Unlike the other VIP versions, all IL-18E 'Salons' were export aircraft. Three were operated by the Chinese Government and the PLAAF. The Polish Air Force had two examples, while the Czech Ministry of the Interior's government flight and the Romanian Government operated one each.

IL-18Gr cargo aircraft

Starting in 1978, a number of *Coots* displaced from the passenger routes by the Tu-154 were converted to freighters designated IL-18Gr (*groozo**voy*** – cargo, used attributively). Outwardly they were no different from any other IL-18 but the interior was stripped out and the cabin floor reinforced. To speed up loading/unloading an electric hoist was provided for moving pallets, travelling along an overhead rail running the full length of the cabin, just as was the case with the IL-18T. However, just like the IL-18T, the IL-18Gr lacked a large cargo door and could only carry items small enough to go through the entry/baggage doors.

The first aircraft to be converted to IL-18Gr configuration was probably IL-18V CCCP-75785 (c/n 181003904). IL-18Gr freighters were operated by various Aeroflot divisions; they typically carried fruit and other perishables from the southern regions of the USSR to Siberia and the Far East. In

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Above: IL-18V CCCP-75834 (c/n 182005104) operated by the Ilyushin OKB was progressively modified to such an extent that it became the prototype of the IL-18E, the interim version preceding the IL-18D in production. It is seen here taking off from Zhukovskiy around 1993, already with the Russian flag and prefix but still wearing Aeroflot titles and logo. Note how the main gear bogies tilt nose-up into vertical position before the main gear struts start pivoting forward.

post-Soviet days many of the surviving IL-18s flew in this configuration.

IL-18 Combi

From the late 1980s onwards many airlines operating the IL-18 modified their *Coots* to a mixed passenger/cargo configuration; the cargo was accommodated in the forward cabin while the passengers sat at the rear where noise levels were lower. Different payload combinations were possible.

IL-18GrM cargo aircraft (IL-18V/F (SCD), IL-18D/F (SCD))

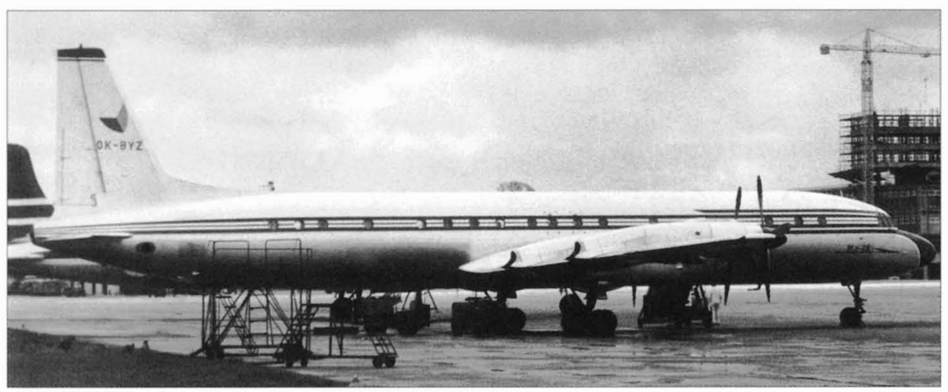
Development of this version was brought about first and foremost by the changing economic situation (to be precise, economic crisis) in Eastern Europe and the Soviet Union in the late 1980s. Actually the idea to develop the IL-18 into a fully capable freighter by incorporating a large pressurised cargo door came into being back in the 1960s when the type was still in production. This modification would enable the IL-18 to swallow a much wider range of loads; later on, when containerised freight transportation became the big hit, the 'Cargo *Coot*' would have proved suitable for it, too.

For obvious reasons the height of the cargo door was less critical as far as the size of the cargo was concerned. Since the fuselage was of circular cross-section, a door making up one quarter of the fuselage's circumference provided an aperture equal to 70% of the cabin height! The door's width was far more important; it had to be chosen carefully because the wider the door, the more it compromised structural integrity.

A possible alternative was to have the entire forward fuselage (as in the case of the Aero Spacelines Guppy freighter based on the Boeing C-97 Stratofreighter) or rear fuselage swing open, making the entire cabin cross-section available for loading and unloading. Canadair successfully used this feature for the CL-44D, a dedicated freighter derivative of the Bristol Britannia four-turboprop airliner on which the rear fuselage was hinged to starboard.

Having already gained some experience with side cargo doors on the IL-12T/IL-12D and IL-14G/IL-14T (which, true enough, were unpressurised), the engineers of OKB-240 did not have to break new ground. Back in the early 1970s the Ilyushin OKB came up with a project envisaging installation of a large upward-opening cargo door on the port side of the IL-18's forward fuselage. Yet not a single aircraft was converted in this fashion for many more years. The reasons were chiefly economic ones – specifically, the economic relations within the Soviet Union and with the 'customer nations' abroad. The chief customer targeted by the project – Aeroflot – already had a sizeable fleet of specialised Antonov An-12 freighters, and the type was still in production at plant No.84 in Tashkent. Moreover, the Ilyushin OKB's own brainchild, the IL-76 *Candid* freighter with both military and civil applications, was about to enter production. Both Aeroflot and the Soviet Air Force had a lot riding on it, which is why Aeroflot, the largest IL-18 operator in the Soviet Union, was none too enthusiastic about such a conversion. This attitude was shared by some people inside the OKB who feared that a possible IL-18 cargo conversion would spoil the *Candid*'s chances.

Foreign IL-18 operators – first and foremost the East European airlines – were in a different situation, having no specialised cargo aircraft (with a few exceptions). As the newer and more capable Tupolev Tu-134 short-haul airliner, Tu-154 medium-haul airliner and IL-62 long-haul airliner were introduced, displacing the old *Coot* from the more prestigious routes and the ones with heavy traffic, the numerous IL-18s found themselves 'laid off' in some cases. Therefore the airlines were interested in prolonging the active career of these rugged and dependable workhorses; after conversion to fully capable freighters these aircraft would fit in perfectly again.



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The IL-18E 'Salon' VIP version was built for export only. This is one of the seven aircraft identified to date – OK-BYZ (c/n 186009004) of the Czech Ministry of the Interior's government flight. It was later sold to ČSA Czechoslovak Airlines as OK-VAF and converted to passenger configuration.

Over the years several air carriers, including Balkan Bulgarian Airlines and Interflug, addressed the Ilyushin OKB with requests to develop a freighter version of the IL-18 with a side cargo door. However, each time the OKB, which had plenty of other irons in the fire, and Aviaexport (the Soviet agency handling aircraft sales to foreign customers) presented such a huge bill for the order that the customers backed off hastily. Things may have worked out differently if the customers had teamed up and placed a joint order, splitting the costs between them to make the venture affordable. Yet for some reason they did not, and eventually most East European airlines were forced to modify some of their *Coots* in a similar fashion to the Soviet IL-18Gr.

It was not until the late 1980s that the Ilyushin OKB finally took on this not very prestigious project. The times were changing. Inflation had depreciated the work of the designers considerably and the book of government orders had shrunk to almost nothing; on the other hand, now that the exaggerated security restrictions were gone, the design bureaux were now authorised to deal directly with foreign customers. Thus the OKB developed a classic side cargo door installation for the IL-18 within just a year (1990-91).

The large upward-opening cargo door measuring 3.5 x 1.825 m (11 ft 5¾ in x 5 ft 11⅞ in) was located ahead of the port wing, replacing the three foremost port side cabin windows, and was actuated by a single hydraulic ram with a breaker strut. A large rectangular reinforcement plate was riveted onto the port side of the fuselage around the aperture. The forward entry door built into the cargo door was moved forward in comparison with the passenger version. The second and third windows on the starboard side were deleted, probably again for structural strength reasons. Thus the window arrangement for a converted IL-18V looked like this: door 2+2+two exits+1+4+door+3 to port and 1+2+two exits+1+4+1+3.

The door featured a perimeter seal, allowing cargo cabin pressurisation to be retained – a major advantage over the An-12 which had an unpressurised freight hold and thus could not carry perishable cargo, such as livestock. The soundproofing mats in the cargo cabin were partially deleted to save weight. For handling containerised or palletised cargo the reinforced cabin floor was equipped with a 'ball mat' near the door and roller conveyors elsewhere, plus cargo tiedown points. Of course, small packages could still be carried in the cabin and the baggage compartments; loading and unloading would be performed using belt conveyors or fork lift trucks. The performance was unchanged as compared to the passenger version.

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Above: An Aeroflot IL-18Gr freighter is loaded by means of a self-propelled belt conveyor loader based on the UAZ-451M 0.8-ton four-wheel drive 'truckster'. The lack of a large cargo door meant the aircraft could carry small items only.

Surprisingly, the new version did not receive any official designation. Unofficially, however, the freighter with a side cargo door was known as the IL-18GrM (*groozo**voy**, modifi**tsee**rovannyy* – cargo, modified).

The launch order was placed by the German airline BerLine which wanted to convert two of the five IL-18s it had acquired after German reunification and the demise of Interflug. The first of the two, IL-18D D-AOAS (ex-DDR-STM, c/n 188010805), arrived at Zhukovskiy in September 1992; the conversion took place in the hangar of the Ilyushin OKB's flight test facility and was completed within four months. The rear passenger cabin and toilet were retained on this aircraft so that passengers accompanying the cargo (or a relief crew) could be carried. The second aircraft, IL-18V D-AOAP (ex-DDR-STI, c/n 185008404) arrived for conversion in February 1993 and was redelivered in June. Depending on their original version, these two aircraft were unofficially known as the IL-18V/F (SCD) and IL-18D/F (SCD) – that is, freighter, side cargo door.

The Romanian carrier Romavia was next, also ordering the conversion of two IL-18Ds. The first of these, YR-IMZ No.2 (c/n 187009802), a former IL-18D 'Salon' VIP aircraft, arrived for conversion in December 1994 and the job was completed on 27th March 1995. YR-IMM (c/n 187009904) was scheduled to be next in 1995 but was never converted; a photo taken in June 1998 shows clearly the aircraft still had no large cargo door!

The fate of the second IL-18GrM – the sole IL-18V/F (SCD) – deserves mention because it was an unusual and an unlucky one. After changing hands several times D-AOAP moved to the Russian civil register as RA-75554 (inheriting the identity of another IL-18V – but that's another story). On 17th December 1997 the aircraft failed to become airborne at Johannesburg-International due to overloading and was damaged beyond repair after overrunning the runway when the take-off was aborted. Three years later the aircraft was broken up but the cargo door was not lost; it was fitted to IL-18D EX-75466 of Phoenix Airlines (c/n 187010403) and the conversion took place at Sharjah between 1st and 3rd March 2001! As for the other IL-18GrMs, D-AOAS became LZ-AZZ with the Bulgarian airline Air Zory, then CU-T132 with the Cuban carrier Aerocaribbean and finally CU-C132. YR-IMZ was sold to the Sri Lankan airline Expo Aviation as 4R-EXD.

Yury Kirsanov

Seen here around 2001, combi-configured IL-18E RA-75834 displays the simple but nevertheless pleasing livery of Moscow-based Titan Aero (now defunct).

Yefim Gordon archive

CCCP-75523, the sole IL-18USh navigator trainer, in the old livery. Note the tandem star trackers and the staggered-tandem ADF strake aerials on top of the fuselage.

IL-18DORR fishery reconnaissance aircraft

In the mid-1980s two IL-18Ds, CCCP-75462 (c/n 187010304) and CCCP-74268 (c/n 188011201), were transferred to the Polar Institute of Oceanic Fishery and Oceanography (PINRO – *Polyarnyy institoot morskovo rybnovo khoziaystva i okeanografii*), most probably from the Moscow Territorial CAD/Domodedovo UAD/212th Flight. After an extensive refit the two *Coots* received the designation IL-18DORR (*dahl'niy okeahnskiy razvedchik ryby* – long-range ocean fishery reconnaissance aircraft). As the designation implies, their mission was to hunt down large shoals of fish for fishing flotillas in international waters.

The mission equipment included spectrometers, multi-mode thermal imaging, photo and video recording equipment and the *Iney* (Hoar frost) photo telegraph data link system for downloading maps to fishing trawlers. Aside from detecting fish, it could measure the concentration of plankton and algae, the water temperature and detect water pollution. The aircraft could also monitor the numbers of marine mammals and perform ice patrol missions in case of need. The IL-18D's long range and endurance meant it could replace more than a hundred fishery reconnaissance vessels!

Outwardly the IL-18DORR could be identified only by two small angular fairings mounted dorsally and ventrally in line with the tenth cabin window on each side (frames 34-36), two additional ventral strake aerials between frames 35-42, an extra wire aerial running from the fin leading edge to a strut at frame 23 and six observation blisters in all three cabins (windows Nos 3, 13 and 14 to port/3, 13 and 15 to starboard). Since they would be flying up north, the aircraft wore Aeroflot's red/white 1973-standard Polar colour scheme (also used by regular transport aircraft flying in the northern areas of the USSR, not only by Polar Aviation aircraft) for high definition against white backgrounds. To make it patently clear this was not a spyplane a large Ministry of Fisheries badge was painted on the nose – no vain precaution, as it turned out, because the aircraft was sometimes intercepted by NATO fighters over international waters.

The first post-conversion flight of CCCP-75462 took place in early 1985. Operations began in 1986, the aircraft operating over the Sea of Norway and the Barents Sea from its temporary base at Murmansk-Murmashi airport where it first arrived from Moscow-Domodedovo on 25th February. These missions implied flying at 300 m (990 ft) and 320 km/h (198 mph), tacking to and fro like an anti-submarine warfare aircraft searching for a sub. Quite often these flights took place at night or at dusk due to the habits of some kinds of fish, added to which, the weather over the Barents Sea was often foul. Missions lasted up to nine hours, including four or five hours on station; all of this placed high demands on the skill of the crew. Up to 26,000 square miles of sea surface could be reconnoitred in a single flight.

Sadly, in the political and economic chaos that followed the demise of the Soviet Union there seemed to be no use for these unique aircraft, so both IL-18DORRs were reconverted to standard IL-18Ds and sold to the Domodedovo Civil Aviation Production Association, subsequently gaining the Russian nationality prefix. RA-75462 was retired in late 1998 and dumped at Moscow-Domodedovo, still in basic polar colours. RA-74268 was more fortunate; after serving with the Domodedovo CAPA in full blue/white colours it was sold to Tyumen' Airlines in 1999.

IL-18D 'Pomor' fishery reconnaissance aircraft

Another IL-18D belonging to GosNII GA (identity unknown) was converted into an ocean fishery reconnaissance aircraft known as the IL-18D 'Pomor'. (In olden days the Pomors were a fishing people living along the White Sea coast in what is now the Arkhangelsk District; the word '*pomor*' itself means 'person who lives by the sea'.) As compared to the IL-18DORR it had more capable mission equipment. Unfortunately no other details are known.

IL-18USh navigator trainer

IL-18V CCCP-75523 (c/n 183006801) was converted into the sole confirmed example of the IL-18USh (*oochebno-shtoormanskiy [samolyot]* – navigator trainer). Outwardly it differed from the standard only in having two dorsal astrosextant blisters (star trackers) located in tandem on the forward fuselage between frames 9-10 and 13-14, slightly offset to port, and two ADF strake aerials in a staggered-tandem arrangement atop the centre fuselage (frames 24-31 and 32-40). The cabin featured 20 trainee workstations with radio and celestial navigation aids.

The aircraft was tested by GosNII GA in early 1972 and found acceptable. The Soviet Air Force, however, rejected the aircraft, probably because the turboprop IL-18 was too slow. Since 1962 it had two versions of the Tu-124 short-haul twinjet to fill the navigator training role – the Tu-124Sh-1 for long-range bomber crews and the Tu-124Sh-2 for tactical bomber crews; these were later succeeded by the Tu-134Sh-1 and Tu-134Sh-2, military derivatives of the Tu-134A.

Several more *Coots* were reportedly converted to IL-18USh configuration. The prototype was probably reconverted to passenger configuration and transferred to Aeroflot's Moscow Territorial CAD/Domodedovo UAD/212th Flight. It was ultimately struck off charge at Moscow-Domodedovo and scrapped.

IL-24N ice reconnaissance aircraft

In the 1970s Aeroflot's Polar division operated at least two Antonov An-24LR *Toros* ice reconnaissance aircraft (CCCP-46210 and CCCP-46395) and a single An-24LR *Nit'* ice reconnaissance aircraft (CCCP-47195). Designed to measure the thickness of ice fields along the Northern Sea Route and indicate the best route for icebreakers leading ship convoys, they were An-24B 50-seat regional airliners equipped with the Toros (Ice hummock) side-looking aircraft radar (SLAR) or an An-24RV with a Nit'-S1 (Thread-S1) SLAR respectively; LR stood for *ledovyy razvedchik* – ice reconnaissance aircraft.

However, a major weakness of the An-24LR Toros and An-24LR Nit' was their rather limited range and endurance. Hence an ice reconnaissance derivative of the IL-18D was developed as a long-range alternative to the Antonov types. The aircraft received a completely separate designation, IL-24N; the designation was reused – as already described in Chapter 2, the original IL-24 was a four-jet bomber which was never built.

Outwardly the IL-24N was extremely similar to the IL-20M *Coot-A* reconnaissance aircraft (see below among the military versions), featuring the same huge elliptical-section pod under the forward fuselage. The pod stretched from frame 8 to frame 27; it was attached via a short blended pylon which began at frame 10. Here the similarity ended, however. Despite the identical design, the pod housed a different SLAR – the civilian Nit'-S1 instead of the military Igla-1, hence the N suffix to the designation. The radar set was housed in the forward baggage compartment and the installation required some local structural reinforcement; the operator's workstations were located in the passenger cabin. An extra wire aerial ran from the fin leading edge to a strut at frame 30. All other excrescences characteristic of the IL-20M were missing, there were two small ventral dielectric blisters fore and aft of the SLAR pod (frames 6-7 and 41-42) which the IL-20M did not have and the window and baggage door arrangement was no different from the standard IL-18D, save that observation blisters were provided in the rearmost window to port and the last-but-one window to starboard.

Two late-production IL-18Ds, CCCP-75449 (c/n 187010004) and CCCP-75466 (c/n 187010403), were converted to IL-24N standard in the mid-1980s. For obvious reasons they wore the red/white polar version of Aeroflot's livery. The IL-24Ns were operated by GosNII GA and were frequently seen on the GosNII GA ramp at Moscow/Sheremet'yevo-1 where they were home-based.

Alas, the IL-24N fell victim to the changing economic situation in Russia in the early 1990s when making money was more important to many people than anything else. After 1992 CCCP-75466 was reconverted to a standard IL-18D; RA-75449 followed suit shortly afterwards. In 1994 both aircraft were sold to the Chelyabinsk-based airline Ramair and are still in use as cargo aircraft.

Test and research aircraft

The IL-18 was also used a lot for various test and research work. There were several reasons making it eminently suitable for this role. Firstly, the spacious cabin (which, as already mentioned, was pressurised – a major advantage over the An-12, another all-time favourite for conversion into testbeds) could accommodate a lot of test equipment and a large crew of researchers, plus all the necessary amenities for the latter. Secondly, the IL-18 possessed a high payload, long range and endurance and the ability to operate anywhere from the tropics to the polar regions in almost any kind of weather. Last but not least, the aircraft was well mastered by flight and ground crews alike and had a broad maintenance network by the time testbeds began appearing.

Avionics testbeds

About 20 IL-18s were operated by various Ministry of Electronics Industry (MRP – *Ministerstvo rahdioelektronnoy promyshlennosti*) divisions as avionics testbeds. While not formally Air Force aircraft, they were mostly used to test military avionics.

By June 1965 IL-18A CCCP-75643 (c/n 188000302) was converted into a testbed for the ***Berkoot*** (Golden eagle) 360° search radar developed for the IL-38 anti-submarine warfare aircraft (see below). The radar was a product of the Leningrad-based NII-131, aka LNPO Leninets (Leninist), now known as the Leninets Holding Co., which owned the aircraft. This establishment, a division of the State Committee for Electronic Equipment (GKRE – *Gosoodarstvennyy komitet po rahdioelektronike*, later transformed into MRP) was one of the Soviet Union's leading avionics specialists.

The radar was installed in identical fashion to the IL-38 in a large quasi-spherical radome immediately aft of the nose gear unit on a faired mounting ring. An unidentified tubular pod on a short pylon was fitted ventrally just aft of the wings. By then the aircraft had been retrofitted with a TG-16 APU. CCCP-75643 has been referred to as the **IL-18SL** (for *samolyot-laboratoriya* – laboratory aircraft); however, in keeping with Leninets' system of designating its avionics testbeds the aircraft was probably designated **SL-18A**.

In the early 1990s CCCP-75643 became a testbed for the GLONASS satellite navigation system (*globahl'naya navigatsionnaya spootnikovaya sistema*, the Soviet equivalent of GPS). The search radar was removed and large cruciform markings were applied to the nose radome; these were possibly some kind of angle reflectors. By May 1992 the aircraft was finally retired and preserved at the 32nd Kilometre railway station a short way from Pushkin near St. Petersburg, home of LNPO Leninets' flight test centre.

IL-18V CCCP-75786 (c/n 181003905) became the **SL-18V** testbed with LNPO Leninets. The aircraft was used to test the *Obzor-K* (Perspective-K) navigation/attack radar developed for the Tupolev Tu-160 bomber. The radar supplanted the RPSN-1 Emblema weather radar and was enclosed by a long conical radome, its large diameter requiring the use of a special adapter with a ventral cutout for the nose gear doors. Small blister fairings were located low on the aft fuselage sides.

A special pylon was installed under the fuselage in line with the forward entry door, permitting carriage of fixed missile acquisition rounds for systems integration purposes. For instance, at an early stage of the programme the SL-18V carried a large acquisition round simulating the Kh-45 ***Molniya*** (Lightning) air-to-surface missile. Originally developed by the Pavel Sukhoi's OKB-51 as the main weapon for the Sukhoi T-4 bomber (development was later continued by the NPO Raduga (Rainbow, pronounced ***rahdooga***) weapons design bureau in Doobna north of Moscow), this weapon was a candidate to arm the Tu-160 for a while but was rejected in 1977.

At the closing stage of its flight test career the SL-18V (by then reregistered RA-75786) was retrofitted with an APM-60 Orsha (a town in Russia) magnetic anomaly detector and associated IL-38-style MAD boom removed from the IL-18D-GAL geophysical survey aircraft (CCCP-74267, see below). Thus RA-75786 became the longest IL-18 ever! The purpose of the modification is unknown.

By 1995 the aircraft had been retired in Pushkin; it was still sitting there engineless in August 2001 as 75786 with no nationality prefix.

An IL-18D with the out-of-sequence registration CCCP-75713 No.2 (c/n 186009403) was yet another LNPO Leninets avionics testbed designated, logically enough, **SL-18D**. This aircraft was used in several

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The second IL-24N, CCCP-75466, on the State Civil Aviation Research Institute (GosNII GA) ramp at Moscow/Sheremet'yevo-1. Note the mudguard on the nosewheels and the accordingly bulged nose gear doors.

Sergey Komissarov

Above: IL-18A CCCP-75643 was converted into the IL-18SL testbed for the IL-38's Berkoot search radar. It is pictured here at Moscow/Vnukovo-1 in June 1965; the radome aft of the nose gear is clearly visible.

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Above: The SL-18V (c/n 181003905) at Leningrad-Pulkovo after repaint in 1973-standard livery. Note the pylon under the forward fuselage for a fixed acquisition round.

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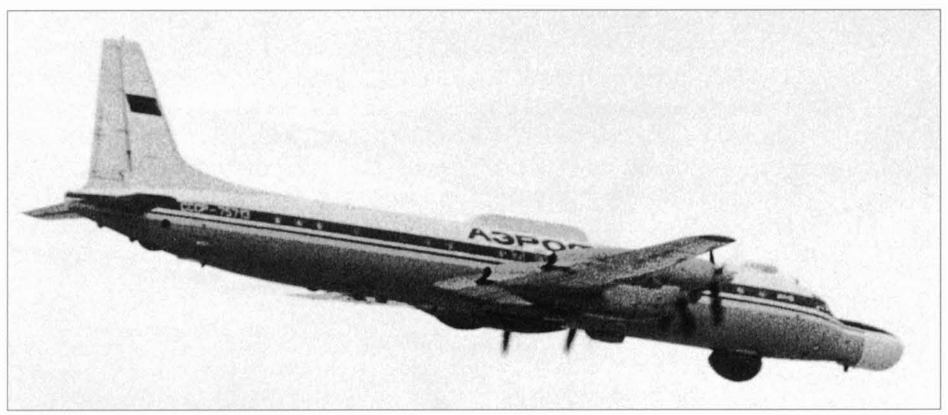
Above: By 1996 the SL-18V had been retrofitted with an APM-60 MAD removed from the IL-18D-GAL (CCCP-74267), making it the longest *Coot* ever. It is seen here languishing engineless in Pushkin.

test programmes and the end result was rather bizarre. The RPSN-1 weather radar gave way to a bulbous nose fairing accommodating a ground mapping radar developed for the Antonov An-124 Ruslan transport. This was compounded by a Berkoot search radar aft of the nose gear unit; hence a mudguard was fitted to the nosewheels and the nose gear doors bulged accordingly.

A small canoe fairing with forward-looking infra-red (FLIR) or laser equipment was mounted on the flightdeck roof, with a larger dorsal canoe fairing over the wing centre section and a small ventral canoe fairing ahead of the wings. The underside aft of the wings bristled with small blade and 'hockey stick' aerials and dielectric blisters. Finally, as on the SL-18V, two small fairings were located low on the aft fuselage sides.



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This in-flight shot of the SL-18D (CCCP-75713 No.2, c/n 186009403) shows well its assorted excrescences.

In 1993 the SL-18D was stripped of experimental equipment and leased to Djibouti-based Daallo Airlines as RA-75713 until October 1994. Today it is operated by NPP Mir, the commercial flying division of the Leninets Holding Company; all non-standard fairings except the mounting for the Berkoot radar have been removed and the aircraft wore large Cyrillic 'NPP Mir' and '*Olimpiada 2004 – Sankt-Peterburg*' titles to indicate St. Petersburg's status as a candidate to host the 2004 Olympic Games (eventually, however, Athens was chosen for this).

IL-18V CCCP-75804 (c/n 182004305) became yet another avionics testbed with LNPO Leninets. Since the V suffix letter was by then allocated to CCCP-75786, this testbed was designated **SL-18I** or **SP-T18I**. Again, the aircraft participated in several test programmes, each one leading to more telltale 'bumps and bulges'. Firstly, the SL-18I was fitted with a non-standard nose radar in an elongated downward-curving radome; the type and application is unknown.

Secondly, once again a Berkoot search radar was installed (with appropriate modifications to the nose gear unit), but this time a large perfectly cylindrical pod with a hemispherical rear end was grafted on to its radome from behind (!); this housed a Mech (Sword) SLAR. Next, a fairly large dorsal teardrop fairing with a hemispherical cupola on top was mounted in line with the overwing emergency exits; this was presumably associated with satellite navigation. Finally, the aircraft had the small blister fairings on the aft fuselage which were common to almost all of the SL-18 series.

In 1993 the SL-18I was likewise stripped of experimental equipment and leased to Daallo Airlines – initially as 75804 (with no prefix) and then as RA-75804. Curiously, all of the non-standard fairings except the dorsal dome were retained, causing many a raised eyebrow wherever the aircraft went; the eye-catching SLAR 'sausage' even caused one Polish writer to mistake 75804 for an IL-20! Today the aircraft wears an Aeroflot-style colour scheme with 'NPP Mir' titles; the ventral radomes have been removed during the latest overhaul but the non-standard nose radome and the mounting for the Berkoot radar still remains.

The last of the SL-18 series – in Russian alphabetical order, that is – was the **SL-18P** converted from the last IL-18E, CCCP-75411 (c/n 186009205). Once again, the aircraft had at least four configurations; unlike the SL-18D and SL-18I, however, it carried equipment associated with only one programme at any one time.

The original configuration dated back to 1966 when the factory-fresh aircraft was converted to test the Taïfoon-M (Typhoon-M) fire control radar developed for the Sukhoi Su-15TM interceptor; this may explain the P suffix (for *perekhvahtchik* – interceptor). Inevitably, the radar (enclosed by a long ogival radome) was installed on an adapter supplanting the RPSN-2 weather radar. A small weather radar 'egg' was mounted on a short pylon on the flightdeck roof.

The second and third configurations of the SL-18P were very similar, being used to test two versions of the PNS-24 Tigr (Tiger) navigation/attack system (*pritsel'no-navigatsionnaya sistema*) designed for the Su-24 *Fencer* tactical bomber. In both cases the short, almost rectangular-section radome terminated in a pitot – a horizontal H-shaped structure (as fitted to the delta-winged Sukhoi T6-1 prototype from which the variable-geometry Su-24 evolved) on the second version and the characteristic F-shaped pitot (popularly known as the 'goose' among Su-24 crews) on the third; the radome itself was dark green and white respectively.

An optical sensor offset to starboard and covered by a rotating hemispherical guard was fitted aft of the nose gear on the second version; on the third this was replaced by a different optical system in a small teardrop fairing. Additionally, a short ventral canoe fairing was located just ahead of the wing leading edge *à la* SL-18D. The 'egg' over the flightdeck was removed

The final version of CCCP-75411 was a testbed for the ***Korshoon*** (Kite, the bird) 360° search radar developed for the Tu-142M *Bear-F Mod* ASW aircraft. The large teardrop radome was fitted, IL-38 style, aft of the nose gear unit; the RPSN-1 weather radar was reinstated and a mudguard added to the nose gear. In this guise the aircraft flew until the early 1990s when the radar was removed; the mounting for the radome remained for a while but was deleted during the next overhaul. Currently RA-75411 is operated by NPP Mir. The Korshoon radar then underwent further tests on a converted IL-38.

IL-18B CCCP-75703 (c/n 189001505) was converted into an avionics testbed of some sort, probably by Moscow-based NPO Vzlyot (Take-off), another Ministry of Electronics Industry division. The aircraft had a shallow boxy fairing immediately aft of the port wing root (probably a synthetic-aperture radar), with two round antennas mounted in line with it closer to the fuselage centreline. The shape of this fairing was changed later in the aircraft's career. A flat-bottomed bulge aft of the nose gear unit revealed that CCCP-75703 had been fitted with a Berkoot search radar which was subsequently removed and the bottom of the mounting ring closed with sheet metal. A

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Above: IL-18V CCCP-75804 (c/n 182004305) was one of the most exotic-looking testbeds of LNPO Leninets. Known as the SL-18I or SP-T18I, it featured a combined search radar/SLAR fairing, a dorsal dielectric cupola and a 'Roman nose' housing a development radar.

small blade aerial was mounted dorsally ahead of the forward entry door and another one ventrally aft of it.

CCCP-75703 was based at LII in Zhukovskiy south of Moscow. Despite its age, the aircraft stayed operational long enough to see the breakup of the Soviet Union, being last noted at Moscow-Bykovo as RA-75703 in June 2000.

In 1984 NPO Vzlyot added IL-18V CCCP-75851 (c/n 182005501) to its aircraft fleet; this was a re-export aircraft, having served with Cubana de Aviación since 1964 as CU-T832. CCCP-75851 became a testbed

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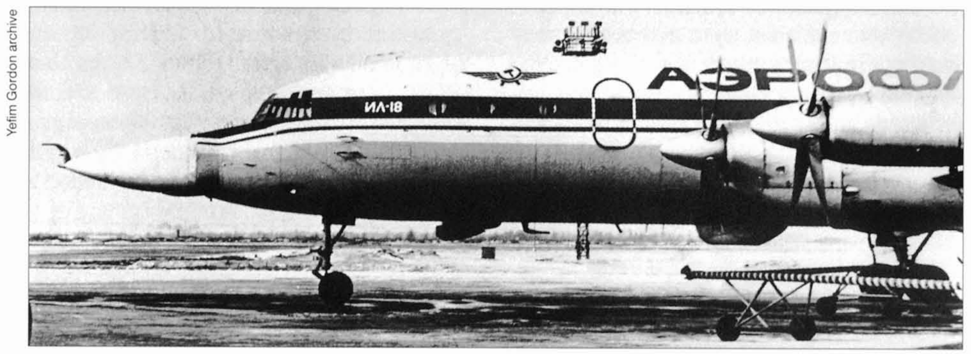
Above: The SL-18P (CCCP-75411, c/n 186009205) as originally flown with the Su-15TM's Taïfoon-M fire control radar. The shiny factory finish is readily apparent. Note the weather radar 'egg' above the flightdeck.



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Above: The SL-18P in its third configuration. The Su-15 nose has been replaced with a late version of the Su-24 bomber's PNS-24 Tigr navigation/attack system with two radars in a common radome. Note the ventral sensor fairings.

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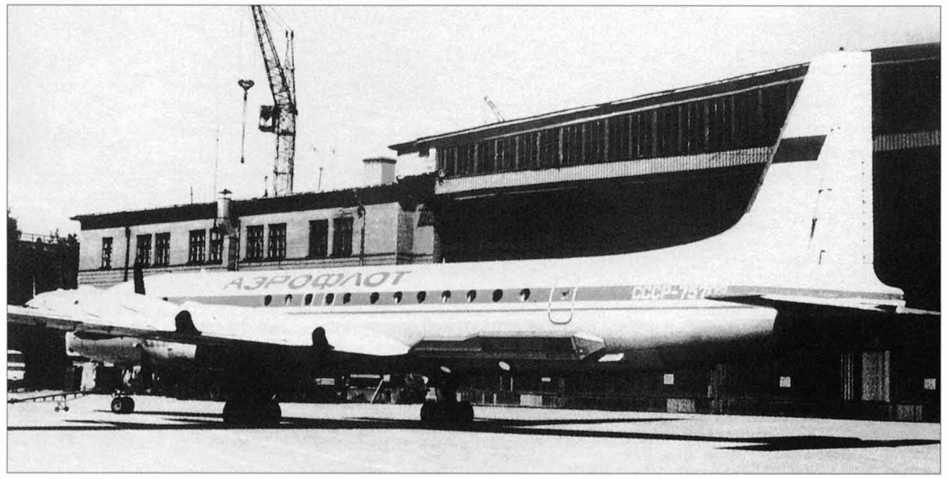
The final test configuration of the SL-18P. The standard RPSN-2 weather radar has been reinstated and a Korshoon search radar for the Tu-142M ASW aircraft fitted aft of the nose gear.



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Above: IL-18B CCCP-75703 (c/n 189001505), an avionics testbed of unknown purpose, seen at aircraft overhaul plant No.402 (Moscow-Bykovo) in the late 1980s. Note the antenna array aft of the port wing root (probably a synthetic-aperture radar).

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Above: IL-18V CCCP-75851 was used by NPO Vzlyot in the mid-1980s to test missile guidance systems. Note the missile tracker head replacing the radome, the ventral and rear sensor fairings and the ventral pod.

for missile guidance systems. The weather radar was replaced by a cylindrical metal fairing terminating in a cone with a dielectric tip and a pronounced 'chin'; the fairing was made to fit instead of the standard radome without requiring any additional modifications to the airframe.

A large detachable pod with the missile's guidance system (acquisition round) was pylon-mounted ahead of the wings, and small angular fairings housing additional equipment were located aft of the nose gear unit and on the fuselage tailcone. By August 1992 CCCP-75851 had been reconverted to standard configuration and was later operated by Elf Air (the commercial division of NPO Vzlyot) as IL-18Gr RA-75851.

An obscure avionics testbed presumably operated by NPO Vzlyot was IL-18V CCCP-78732 (ex-CCCP-75794, c/n 181004103). The non-standard registration is noteworthy, since the 787xx series is allocated to Ilyushin IL-76MD transports and IL-78/IL-78M tankers. The aircraft had a small cylindrical pod with a hemispherical front end and a pointed rear end under the forward fuselage, plus a small flat-topped dorsal fairing near the aft entry door. It was last noted at LII as RA-78732 in March 1994 minus the ventral pod and was reportedly operated by Volare, LII's own airline, at the time.

A former Soviet Air Force IL-18V with the out-of-sequence registration CCCP-75894 (c/n 182004801) was converted into an avionics testbed by NPO Vzlyot before 1992. The aircraft featured a large canoe fairing under the forward fuselage (with a downward-projecting 'thimble' at the rear) and a smaller ventral 'bathtub' aft of the wings, both incorporating large dielectric panels. It is still based at Zhukovskiy in this condition as RA-75894.

Sometime before 1973 IL-18V CCCP-75811 (c/n 182004504) was converted into the **IL-18REO** testbed (*__rah__dioelek__tron__noye obo__roo__dovaniye* – electronic equipment) by the Moscow Institute of Electronics (MIREA). The nose radome gave place to a long cylindrical metal 'plug' terminating in a dielectric fairing which looked like an outsize match (to use the mildest of comparisons). A large cylindrical pod with a hemispherical front end and an ogival rear end (both dielectric) was installed under the forward fuselage. The nature of the equipment tested is unknown.

Later, CCCP-75811 was fitted with a Berkoot search radar, a small dielectric blister over the wing centre section and a small ventral canoe fairing aft of the wings. Interestingly, the search radar was located noticeably farther aft than on the SL-18D and SL-18I. In 1996, long after this equipment had been removed, the aircraft was operated by the Ilyushin OKB's own airline, Ilavia, as RA-75811; by August 1999 it had been sold to Elf Air.

In 1965-66 (some sources say 1968) the Experimental Machinery Plant headed by Vladimir M. Myasishchev (formerly OKB-23) operated an aircraft designated **IL-18 'Polosa'** (Stripe, pronounced *polo__sah__*) or **IL-18P**. This was probably a modified IL-18V in pre-1973 colours with the non-standard registration CCCP-06180 (c/n unknown). It had small cheek fairings immediately aft of the radome and small square fairings on the sides of the fin about halfway up; these incorporated slot aerials.

Sergey and Dmitriy Komissarov archive

IL-18V CCCP-78732 was an avionics testbed of unknown purpose apparently belonging to the Myasishchev OKB. This view shows the small cylindrical pod under the forward fuselage.

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Above: CCCP-75811 (c/n 182004504), the IL-18REO avionics testbed, in early configuration. No comments on the shape of the nose please...

The IL-18P served to test an experimental navigation system permitting automatic flight along a predesignated route and automatic approach/landing.

An IL-18A or IL-18B with the non-standard registration CCCP-48093 (c/n unknown) was yet another obscure avionics testbed with a large flat-bottomed fairing under the extreme aft fuselage. Upon retirement the aircraft was preserved in a pioneer camp near St. Petersburg; the registration was reused in 1989 for an An-32 transport.

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Above: CCCP-75811 in later guise, probably photographed at Pushkin. Note that the Berkoot search radar is positioned much further aft than on the IL-18SL and SL-18D. The dorsal dielectric blister and ventral 'bathtub' are just visible in this view.

Weather research aircraft

IL-18V 'Meteor'

One of the first *Coots* to be converted for research purposes was former IL-18V 'Salon' CCCP-75716 (c/n 180001902), a 235th IAD machine which had been the 'presidential' aircraft of Nikita S. Khrushchov. By 1963 it had been transferred to Aeroflot's Polar Directorate, giving way to a newer example.

In 1963 CCCP-75716 was fitted out as a weather research aircraft by MMZ No.30 for the Central Aerologic Observatory (TsAO – *Tsen**trahl'**naya **a**ero**logi**cheskaya observa**to**riya*), a division of the Soviet Union's State Committee for Hydrometeorology and Environmental Control (Goskomghidromet). Part of the research equipment was installed in a large canoe fairing under the forward fuselage (outwardly identical to that of CCCP-75431, see below); another external recognition feature was a satellite communications antenna in a small dielectric dome above the wing centre section. The total weight of the equipment suite was about 4 tons (8,820 lb).

At first the aircraft's mission was to corroborate the data supplied by weather research satellites. These were only beginning to gain wide use and had yet to prove their worth. Later, when the weather research satellites had earned their credentials, TsAO started using CCCP-75716 for other tasks; the first of these was monitoring the launches of weather research rockets in the High North. Such flights occasionally involved participation of foreign scientists who were quick to recognise both the considerable capabilities of the aircraft itself and the skill of its crew (high flying skill was a requirement, since the flight profiles were rather unusual). They were in a position to form an opinion, as prior experience they had gained with other weather research aircraft was far less encouraging. The aircraft was also used for investigating jetstreams, turbulence (the clear-air turbulence phenomenon was already recognised as a flight safety threat in those days), storm fronts and the upper reaches of the atmosphere, including the ozone layer.

As the research missions changed, so did the equipment suite. The refitting jobs

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IL-18V RA-75894, another obscure avionics testbed belonging to NPO Vzlyot, takes off from runway 12 at Zhukovskiy. The large ventral canoe fairings are clearly visible.

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Above: IL-18V CCCP-06180 was probably the IL-18 'Polosa' (IL-18P) used by the Myasishchev Design Bureau to test an experimental navigation system. Note the fairings on the sides of the nose and fin housing slot aerials.

were performed at various locations – the LII airfield in Zhukovskiy, MMZ No.30's flight test facility at Lookhovitsy-Tret'yakovo and Chkalovskaya airbase.

In 1968 IL-18V CCCP-75716 was formally reassigned to the 63rd Flight which was part of the Central Directorate of International Services (TsUMVS – *Tsen**trahl'**noye ooprav-**len**iye mezhduna**rod**nykh voz**doosh**nykh so'ob**shchen**iy*) at Moscow-Sheremet'yevo. Its actual owner and operator, however, was GosNII GA and the aircraft was still used for weather research. The canoe pod under the forward fuselage was removed in March 1974, since the programme it was associated with had ended. Since CCCP-75716 could work in conjunction with Meteor weather research satellites, it was unofficially designated IL-18V 'Meteor'. Experience gained with this aircraft allowed the best ways of placing and using various meteorological equipment to be determined and later put to good use on other aircraft.

IL-18E 'Meteor'

In 1976 IL-18V 'Meteor' CCCP-75716, which was manufactured in 1960, was approaching the limit of its 20-year designated service life and a replacement aircraft had to be procured. It was another year before GosNII GA was able to provide the Central Aerologic Observatory with a newer *Coot*, IL-18E CCCP-75598 (c/n 186008802), which also possessed longer range.

Not wishing to be snared in miles of red tape while obtaining all the necessary clearances for outfitting a new weather research aircraft from scratch, TsAO requested permission to simply transfer the existing equipment from CCCP-75716 to the new aircraft. Permission was quickly granted and the work went ahead. On 24th October 1977 the former IL-18V 'Meteor' was transferred to Ul'yanovsk Higher Flying School, the Soviet Union's top-notch civil aviation flying college, where it served on as a trainer until finally retired in 1980.

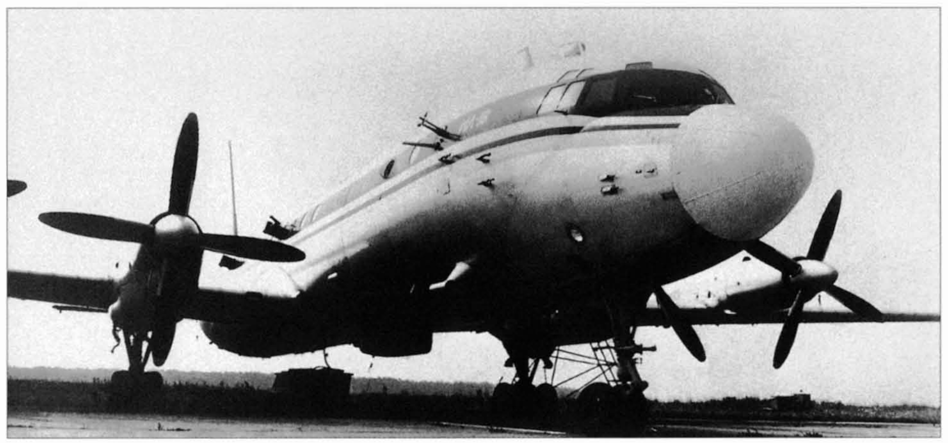
Designated IL-18E 'Meteor' by analogy with its predecessor, CCCP-75598 featured a specialised BMR-1 weather research radar in a rather large round flat-bottomed radome under the wing centre section. The radar set was located in the forward baggage compartment and accessible from the cabin via several maintenance hatches allowing the radar to be promptly fixed in flight, should it fail. Numerous air sampling traps and sensors were mounted on short struts on the forward and centre fuselage and under the wingtips, including sensors in the foremost and rearmost cabin windows to starboard and air traps in the forward emergency exit (7th window) and 13th window to starboard. Observation blisters were provided in the 2nd and 13th window to port and the 3rd window to starboard. Vertical cameras were installed in the front and rear cabins, while the toilets were transformed into photo processing labs, allowing the films to be developed and photos printed on board.

The conversion job, which was performed by MMZ No.240 at Moscow-Khodynka, was completed in June 1977. For more than 20 years CCCP-75598 served faithfully in the weather research role, taking part in numerous scientific experiments held both in the Soviet Union and abroad. By 1991, however, it became clear that the IL-18E 'Meteor' was not being used to the full in its intended capacity, so GosNII GA proposed using the aircraft for cargo charter flights in order to generate revenue. Then, faced with the decline in the number of research programmes and skyrocketing aircraft leasing charges, TsAO had to give up using the IL-18E 'Meteor' and the aircraft was modified for other uses (see below).

IL-18D 'Tsiklon' (IL-18DTs)

In the mid-1970s the Central Aerologic Observatory commissioned development of a series of weather research aircraft under the common name *Tsi**klon*** (Cyclone). By then radar technologies of weather and atmospheric research had gained wide use. The use of radar made it possible to study the distribution of clouds and precipitation over wide areas and follow the development of storm nuclei. The techniques employed by the Tsiklon system allowed stand-off research of clouds – that is, without actually entering them, which could change their shape and structure (and could be dangerous for the aircraft itself, considering that severe turbulence is often encountered in clouds, not to mention lightning!). Apart from studying the principal thermodynamic and electric parameters of the atmosphere and cloud formations, the aircraft were designed to perform cloud-seeding missions in order to make rain – for example, when it was necessary to prevent an impending hailstorm which could destroy crops, or to scatter rain clouds which could ruin a public holiday.

One of the seven assorted aircraft in the series was based on the long-range IL-18D – specifically, CCCP-75442 (c/n 187009702) – and designated IL-18D 'Tsiklon'. Outwardly it sprouted all manner of 'bumps and bulges' so characteristic of research aircraft. A pointed boom 4 m (13 ft 1½ in) long tipped with sensors was installed on the left side of the nose ahead of the flightdeck glazing,



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IL-18E CCCP-75598 (c/n 186008802) was modified by GosNII GA as the IL-18E 'Meteor' weather research aircraft. These views show the many sensors and air probes on the fuselage and the ventral fairing of the BMR-1 weather research radar.

Sergey and Dmitriy Komissarov archive

The IL-18D 'Tsiklon' (CCCP-75442, c/n 1878009702) in flight, showing off its sensor array on the centre/aft fuselage and wings.

increasing overall length to 40 m (131 ft 2¾ in); it was painted in black and white stripes to avoid damage by ground vehicles. A specialised K-11M weather research radar in a deep teardrop radome with flattened sides was installed immediately aft of the nose gear unit (frames 5-11), requiring the nosewheels to be fitted with a mudguard and the nose gear doors bulged accordingly.

In a similar fashion to the SL-18D, a FLIR or laser equipment housing was mounted on the flightdeck roof and two shallow dielectric canoe fairings were fitted above and below the fuselage in line with the wing leading edge. Two elongated square-section fairings with apertures for laser measurement systems took the place of the two rearmost cabin windows on each side. Numerous sensors were mounted on struts just aft of the flightdeck. The lower fuselage incorporated two optically flat camera windows protected by sliding doors for take-off and landing. An extra wire aerial ran from the fin leading edge to a strut above the forward entry door. Finally, two observation blisters were provided in the3rd and 13th cabin windows on each side, plus two dorsal observation blisters in line with the rear pair of emergency exits and ahead of the rear entry door. The eye-catching Tsiklon emblem was painted on the nose to clarify the aircraft's 'storm chaser' role.

The mission equipment comprised a measurement suite, data recording/processing suite and cloud-seeding equipment. The measurement suite included, first of all, a thermodynamic measurement system comprising a TsSV-3M-1KM central air data system, an EM TsAO electrometeorograph, a PK G-load measuring kit, an SAMB-70 airborne automatic weather research module, an ASTA-74 airborne automatic thermoanemometer, a DISS-013-134 Doppler speed/drift sensor system, an RV-18Zh radio altimeter, an ISVP airflow structure meter and an SG-1 airborne humidity meter. It recorded the outside air temperature and its fluctuations, the aircraft's speed and heading, the wind speed and direction, airflow pulsations, static and dynamic air pressure, barometric and true altitude, vertical gusts and G loads acting on the aircraft. The second major component was the cloud and precipitation microstructure measurement system comprising an RP-73 translucency recorder, an IRCh water/ice particle size meter, an SALYa atmospheric ice particle counter, SEIV-3 and IVO airborne electric cloud water content meters and an AFSO cloud phase analyser. The third component was the meteorological radar and laser system – the aforementioned K-11M search radar, a BMR-1A radar for vertical scanning of the atmosphere and an LR-3P laser polarisation meter. The fourth component was the radiometric system comprising the RAK radiometric/actinometric complex and the TETA radiometric module. Finally, there was a PNP meter for measuring electric fields and the aircraft's electric charge.

The BARS-1 data recording/processing suite ('bars' means 'snow leopard', but in this case it is an acronym for *borto**va**ya avtoma**tich**eskaya reghis**tree**ruyushchaya siste**ma*** – on-board automatic recording system) consisted of a K60-42 magnetic recorder, a PTU-31-1-7 video recording system, a forward-looking AKS-2 ciné camera on the starboard side of the nose, an AFA-BAF-21S photo camera and an SYeO common time indication system. The K60-42 automatically recorded signals generated by the thermodynamic and cloud measurement systems for future computer analysis.

Yefim Gordon archive

This aspect of the IL-18D 'Tsiklon' weather research aircraft gives a good detail view of the instrumented nose probe, the K-11M weather research radar aft of the nose gear, the ventral ASO-2I rainmaking chemical dispensers immediately aft and the plethora of sensors on the forward fuselage.

ITAR-TASS

Above: IL-18V CCCP-75431 (c/n 180002003), a survey aircraft operated by the Main Geophysical Observatory, flies over the North Sea during the POLEX-Sever-76 experiment. The picture was taken from IL-18V 'Meteor' CCCP-75716 shortly before the latter was reconverted to standard configuration. Here CCCP-75431 is seen in pre-1973 colours; later it gained a non-standard 'quasi-Polar' colour scheme with a red cheatline but no red colour on the tail and outer wings.

The ciné and photo cameras were used to film the outside conditions, using the observation blisters. A film processing lab was provided in the rear cabin.

The cloud-seeding equipment designed to generate rain from cumulus and stratus clouds included three KDS-155 dispensers and three ASO-2I dispensers mounted on the centre fuselage underside (frames 17-23). The most widely used among the latter is silver iodide. The KDS-155 and ASO-2I were adapted from stock chaff/flare dispensers used on Soviet military aircraft for passive electronic and infra-red countermeasures. Instead of bundles of chaff, aluminium-coated glass needles or PPI-26 IRCM flares they fired special PV-26 cartridges with chemicals triggering the formation of ice crystals. The latter would become too heavy to be supported by the air currents inside the cloud and start falling as hailstones; however, these melted and turned into rain before reaching the ground.

The aircraft had a flight crew of five and a 34-man team of researchers who sat behind 19 single and dual equipment consoles installed in all three cabins.

The first post-conversion flight took place on 4th April 1980. The maximum take-off weight was 64 tons (134,480 lb), including a 9.4-ton (20,720-lb) payload; the various external outgrowths reduced the cruising speed to 625-650 km/h (388-403 mph) and the service ceiling to 8,650 m (28,380 ft). The aircraft could stay airborne for up to eight hours, with a maximum range of 4,270 km (2,650 miles).

The IL-18D 'Tsiklon' had quite an active service career, flying both at home and abroad (among other things, it periodically deployed to Cuba to chase tropical hurricanes). After the demise of the Soviet Union it was reregistered RA-75442. Unfortunately, like some other research aircraft, the IL-18D 'Tsiklon' fell victim to unscrupulous businessmen to whom profits were more important than science – in 1997 it was stripped of all mission equipment, leased to a succession of airlines and finally sold.

Geophysical survey aircraft

In late 1972 or early 1973 an IL-18V with the out-of-sequence registration CCCP-75431 (c/n 180002003) was transferred to the Main Geophysical Observatory named after A. I. Voyeikov (GGO) and converted to a geophysical survey aircraft. It featured a large canoe fairing under the forward fuselage with four ventral apertures for sensors and cameras; the lower portion could swing open to starboard for maintenance. A large teardrop-shaped metal fairing incorporating three dielectric panels was installed ventrally just aft of the wings. The first, third and tenth cabin windows to starboard were blanked off with metal plugs mounting small sensors; another sensor was installed on a short strut above the wing trailing edge. The rear emergency exit to starboard had a non-standard windowless cover.

CCCP-75431 participated in assorted research programmes held in the interests of various ministries. For instance, on 3rd April 1975 the aircraft took off from its home base of Leningrad-Pulkovo, heading for Karaganda. The mission was to survey arable lands in the Karaganda, Tselinograd and Kokchetav Regions of Kazakhstan in preparation for the wheat sowing campaign, determining how much water was needed for irrigation. The IL-18 worked in conjunction with a specially modified An-24 airliner and an An-30 photo survey aircraft. Similar land survey missions were flown in the spring of 1977 in such far-apart areas of the Soviet Union as the Krasnoyarsk Region in West Siberia, the Stavropol' Region in southern Russia and the southern regions of the Ukraine, all major providers of grain.

A year earlier CCCP-75431 was involved in the POLEX-Sever-76 ('Polar Experiment – North 1976') together with another 'curious *Coot*', the IL-18V 'Meteor' (CCCP-75716), operating from Amderma and working together with the research vessel M/V *Professor Wiese*. In the same year it participated in the SAMEX (*Sovetsko-amerikahnskiy [mikrovolnovyy] eksperiment* – Soviet/US Microwave Experiment), measuring the condition of the sea and atmosphere in two designated areas of the Pacific Ocean near the Kamchatka Peninsula and the Kurile Islands. The experiment also involved a modified Convair CV 990 Coronado, the Soviet research vessel M/V *Akademik Korolyov* and the Nimbus-5 and Nimbus-6 satellites.

Sergey and Dmitriy Komissarov archive

Sometime before 1987 IL-18D CCCP-74267 (c/n 188011105) was converted into the IL-18D-GAL geophysical survey aircraft (aka IL-18D 'Antarktida') equipped with an IL-38 style MAD boom.

By 1992 CCCP-75431 had been transferred to LII and all survey equipment had been removed, thus turning the aircraft into an IL-18Gr freighter.

IL-18D-GAL (IL-18D 'Antarktida')

By 1987 IL-18D CCCP-74267 (c/n 188011105), which by then had been in use for several years for supporting Soviet Antarctic research stations, was modified for geophysical survey in Antarctica. To this end a boom carrying an APM-60 magnetic anomaly detector borrowed from the IL-38 was fitted instead of the usual tailcone; the mission equipment and operators' workstations were installed in the cabin. In some documents the modified aircraft was called IL-18D-GAL (*gheofi**zich**eskaya **a**erolabora**toriya*** – geophysical flying laboratory), while a newspaper publication referred to it as the IL-18D 'Antarktida' (Antarctica).

The 'stinger tail' IL-18D took part in the 32nd Soviet Antarctic expedition which started off from Moscow on 26th September 1987. Taking off from Moscow-Sheremet'yevo, the aircraft captained by V. Ya. Shapkin made the short trip to Leningrad to pick up the team of polar researchers, then flew to Ice Station Molodyozhnaya via Odessa, Cairo, Aden and Maputo. Upon arrival CCCP-74267 made a series of survey flights over the South Pole and the so-called Pole of Inaccessibility – a part of the glacial continent which is truly hard to reach.

In 1989 the aircraft was contracted by the Norwegian company Amarok to undertake magnetic monitoring of the sea shelf north of Spitsbergen (Svalbard) Islands commissioned by the Conoco, Elf-Aquitaine and Statoil petroleum companies. The work was performed by a team from the Soviet specialist organisation Sevmorgheologiya (the North Sea Geology Trust). Operating from Murmansk-Murmashi and Longyear (the airport of Spitsbergen), CCCP-74267 flew fourteen sorties between 20th April and 11th May, inspecting an area of 50,000 km² (19,305 sq miles). The flights proceeded at 600-900 m (1,970-2,950 ft) along 23 routes.

In post-Soviet days the IL-18D-GAL was stripped of special equipment and sold to the Domodedovo Civil Aviation Production Association as RA-74267.

In the autumn of 1991 the former IL-18E 'Meteor' weather research aircraft (CCCP-75598) was stripped of its mission equipment and converted into a geophysical survey aircraft with an *izdeliye* A-723 side-looking aircraft radar. The SLAR, which was developed by the Electronics Institute of the Ukrainian SSR's Academy of Sciences, was installed in a large slab-sided fairing aft of the port wing and a ventral fairing in line with it.

Upon completion of this programme GosNII GA reconverted the aircraft to standard configuration with a 72-seat tourist-class layout and leased it to the Moscow-based charter airline IRS-Aero as RA-75598.

Environmental monitoring aircraft

In the 1980s an IL-18V with the out-of-sequence registration CCCP-75423 (c/n 182005601) was extensively modified for environmental monitoring and research tasks by LII and MIREA. Its main external identification feature was a large cylindrical pod under the forward fuselage housing a SLAR based on the Mech system (the pod was very similar to the one on the SL-18I); this and the unusual 'quasi-Polar' red/white colour scheme identical to the one worn by CCCP-75431 until 1995 caused some people to mistake it for an IL-24N. At an altitude of 6,000 m (19,685 ft) the radar could scan a strip of land 20 km (12.4 miles) wide.

A flat-bottomed ventral 'bathtub' with a large dielectric panel (similar to that of IL-18V CCCP-75894) was installed aft of the wings. Finally, four angular fairings incorporating optically flat glass windows were provided for operating optical sensors or spectrometers. One such window was located dorsally just aft of the forward entry door, looking up at about 45° to the direction of flight; a second window placed on the port side just a little further aft was directed about 45° upwards, while the other two windows located fore and aft of the rear entry door looked 45° down.

CCCP-75423 was in the static park at MosAeroShow-92, Russia's first real international airshow, at LII's airfield from 11th to 16th August 1992. The official exhibitors catalogue at the MAKS-93 airshow referred to this aircraft as the IL-18 ZhLIIP (*Zhoo**kov**skoye **lyot**no-ispy**tah**tel'noye is**sle**dovatel'skoye predpri**yah**tiye* – Zhukovskiy Flight Test & Research Enterprise), though this is hardly its proper designation.

In 1993 the aircraft received the Russian prefix; by August 1997 it had been withdrawn from use. Finally, in early 1999 RA-75423 was restored to airworthy status for ferrying to Pushkin; there in the course of a complete refurbishment at the Russian Navy's aircraft overhaul plant No.20 it was stripped of all non-standard appendages and converted to combi configuration for its new owner, IRS-Aero.

IL-18LL de-icing systems test aircraft

In the early 1960s the sixth production IL-18A, CCCP-Л5821 (c/n 188000201), was transferred to LII which converted it for testing the de-icing systems of other aircraft. In this form the aircraft was known as the IL-18LL (*le**ta**yuschchaya labora**to**riya* – lit. 'flying laboratory').

The changes to the IL-18LL's airframe were quite extensive. A flat-topped superstructure was fitted to the centre fuselage for mounting the test article – a section of airframe incorporating de-icing system elements. To create artificial icing conditions a large circular sprinkler grid with bracing struts at the front was mounted ahead of the wing centre section; the cabin accommodated a water tank and test equipment consoles. Ciné cameras installed in angular fairings on top of the outer engine nacelles captured the ice formation on the test article.

In 1965 the IL-18LL was used to verify the de-icing systems developed for the wings of the IL-62 long-haul airliner and engine air intakes of various high-speed combat aircraft. According to test pilot Yakov I. Vernikov who captained the aircraft, the added area above the centre of gravity (CG) made the testbed sensitive to crosswinds, complicating flying, especially at low speeds.

Towards the end of the decade the aircraft (by then reregistered CCCP-75637) was reconverted and used in another test

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IL-18V CCCP-75423 (c/n 182005601) was modified for environmental monitoring and research by LII and MIREA. This view shows the SLAR pod under the forward fuselage and the ventral 'bathtub' aft of the wings.

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IL-18A CCCP-Л5821 (ie, SSSR-L5821, c/n 188000201) was converted by LII as the IL-18LL de-icing systems testbed. Here the test article installed on top of the fuselage is a section of the IL-62 airliner's wing.

programme, yielding its icing test mission to An-12BK CCCP-48974.

IL-18LL engine testbed

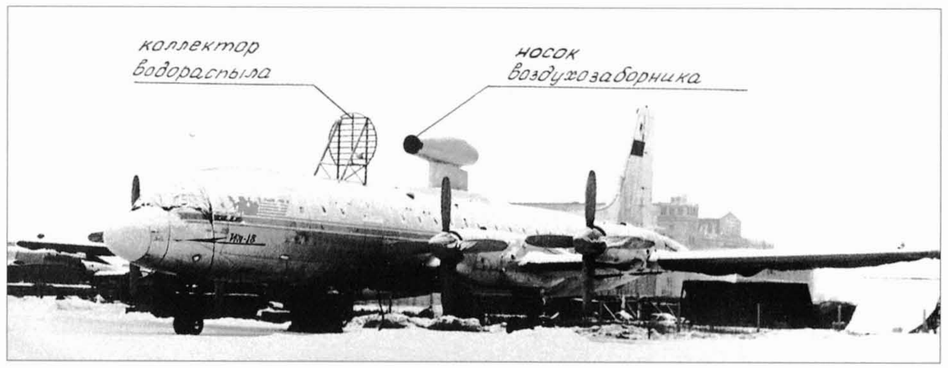
Rather confusingly, the IL-18LL designation also applied to a very different testbed, and not a Soviet one at that. In late October 1987 VZLÚ, the Czech equivalent of LII, purchased IL-18V DDR-STC (c/n 180002202) from the East German carrier Interflug. After a minor overhaul the airliner was registered OK-018 on 30th November 1987; the three digits instead of the usual three letters after the registration prefix indicated test or development status.

The aircraft's mission was to test the intended powerplant of the Let L-610 twin-turboprop regional airliner. A Walter (later Motorlet) M-602 turboprop driving an Avia V-518 five-blade reversible-pitch propeller was installed in place of the No.2 AI-20K. The aircraft retained basic Interflug colours.

The tests went successfully, allowing the L-610 prototype (OK-130, later reregistered OK-TZB) to enter flight test on 28th December 1988. Meanwhile, the IL-18LL was withdrawn from use and finally scrapped in January 1996 after sitting at Prague-Letňany for several years.

IL-118 airliner project

Trying to prolong the active life of the IL-18s remaining in service, in the summer of 1984 the Ilyushin OKB proposed an upgrade eloquently designated IL-118. It involved a rather radical redesign of the *Coot*, the four



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Above: The IL-18LL in a different configuration for testing an air intake de-icing system. Judging by the shape of the test article, the intake assembly appears to be that of the Yakovlev Yak-28 tactical bomber.

Yefim Gordon archive

Yet another configuration of the IL-18LL with a test article resembling an F-104 style air intake – as used on the Tupolev Tu-128 heavy interceptor.

AI-20 turboprops being replaced by two 10,900-ehp Lotarev D-236T propfan engines driving SV-36 low-noise contra-rotating propellers of 4.2 m (13 ft 9⅜ in) diameter. Developed by the Stoopino Machinery Design Bureau, the SV-36 featured glassfibre blades with a hollow composite spar and integrated electric de-icing threads. The front and rear rows had eight and six blades respectively, running at 1,100 and 1,000 rpm respectively; the difference in speed was intended to reduce noise and vibration. The engine was a derivative of the D-136 turboshaft powering the Mi-26 helicopter.

The IL-118 was to offer much better fuel efficiency compared not only with the IL-18 but with the jet transports then in service. Yet the project never got beyond the preliminary design stage because all-new designs seemed to offer greater advantages.

IL-18 – structural description

The following structural description applies to the standard IL-18V. Details of other versions are given as appropriate.

Type: Four-engined medium/long-haul airliner. The airframe is of all-metal construction and is mostly made of D16A-T duralumin; some structural elements are made of AK6 an AL9 aluminium alloys, ML5-T4 magnesium alloy and 30KhGSA or 30KhGSNA grade steel.

Fuselage: Semi-monocoque stressed-skin structure of beam-and-stringer construction with 78 stamped frames which are mostly set at 0.5 m (1 ft 7⅝ in) intervals; the skin thickness varies from 1.5 to 1.8 mm (0.059-0.07 in). The structure is riveted. Frames 16-20 located in and around the propellers' plane of rotation are interceded by doubler frames at 0.25 m (9⅞ in) intervals – that is, frames 16, 16A, 17, 17A and so on – for higher fatigue resistance. The cross-section is mostly circular, changing to quasi-oval at the rear; maximum fuselage diameter 3.5 m (11 ft 5¾ in), fineness ratio 9.85.

Structurally the fuselage is divided into three sections. The *forward fuselage* is the flightdeck section (frames 1-3); actually, however, the flightdeck continues aft into the centre fuselage, terminating in a flat rear bulkhead (frame 5). An unpressurised nose fairing is grafted on ahead of the forward pressure dome, its frames are designated by letters in Russian alphabetic sequence (A-B-V-G-D). This fairing accommodates part of the nosewheel well which goes all the way from frame A to the forward fuselage's frame 4, encroaching on the pressure dome; frame A is a bulkhead mounting the weather radar dish and the glassfibre radome hinged to starboard.

The flightdeck glazing features four windshield panels made of birdproof triplex glass, six side windows and six eyebrow windows with Perspex glazing. The foremost side windows are sliding direct vision windows.

The *centre fuselage* accommodates the passenger cabins, the Nos 1 and 2 underfloor baggage compartments and two avionics/equipment bays terminating in a rear pressure dome. It has a ventral cutout for the wing torsion box carry-through structure. Together with the flightdeck it forms a single pressure cabin; however, the flightdeck bulkhead is designed to withstand the pressure differential if either the flightdeck or the cabin decompresses.

Maximum cabin width is 3.232 m (10 ft 7¼ in) and cabin height 2.0 m (6 ft 6¾ in).

The centre fuselage features two 0.45 x 0.75 m (1 ft 5¾ in x 2 ft 5½ in) overwing emergency exits on each side between frames 27-28 and 29-30, as well as circular windows of 400 mm (1 ft 3¾ in) diameter. The windows feature double glazing. The number of windows varies, depending on the version. The IL-18V had 15 windows to port and 16 to starboard.

Two plug-type entry doors measuring 0.758 x 1.4 m (2 ft 5⅞ in x 4 ft 7⅛ in) are provided on the port side. On the IL-18 *sans suffixe* and IL-18A/B the doors were located at the extremities of the cabin and opened by pushing inwards and sliding towards the nose (forward door) or the tail (rear door). The IL-18V introduced a different arrangement with the doors located closer to the wings so that the entry vestibules separated the three cabins; the forward door slid towards the tail when opened and the rear door towards the nose. The baggage compartments are accessed via rectangular doors on the starboard side opening inwards and upwards.

The *rear fuselage* is unpressurised. It incorporates the No.3 baggage compartment with an upward/outward-opening door to starboard.

Wings: Cantilever low-wing monoplane with wings of trapezoidal planform. The wings are of stressed-skin construction. Dihedral 3°, incidence 3°, camber –1° on the outer wings, aspect ratio 10, taper 3.

Structurally the wings are made up of three pieces: the monobloc centre section built integrally with the inner wings, which carry the engine nacelles, and detachable outer wing panels. The three-spar centre section/inner wings spanning 21.9 m (71 ft 10¼ in) have 49 ribs (of these, the centreline rib 0 and ribs 1-4 on each side are inside the fuselage), 36 stringers and a skin thickness of 3-6 mm (0.11-0.23 in). The outer wings are of two-spar construction, featuring 18 ribs, 26 stringers and a skin thickness of up to 2.5 mm (0.098 in). A TsAGI S-5 airfoil is used on

Andrey Yurgenson

Four views of a typical production IL-18D.

the inner wings between the fuselage and the inboard engines, while the two-spar outer wings utilise the S-3 airfoil, with an intermediate airfoil section in between; thickness/chord ratio 16% at the roots and 13% at the tips.

The leading-edge fairings are detachable; the wing skins incorporate numerous removable panels for access to the control runs, hydraulic and electric system components, fuel tank filler caps and fuel meters.

The inner wings are equipped with one-piece double-slotted flaps occupying 19.39% of the wing area and 63.8% of the span. The flaps are actuated by an MPZ-9A twin-motor electric drive located on the rear spar via drive shafts and combined angle drives/screwjacks (two for each flap); they move on curved tracks housed entirely inside the wings. Flap settings are 15° or 30° for take-off and 40° (later reduced to 30°) for landing. There are two-section ailerons on the outer wings; each aileron section is suspended on three brackets.

Tail unit: Conventional tail unit of all-metal stressed-skin construction. All tail surfaces use a modified NACA-00 symmetrical airfoil with a thickness/chord ratio of 12%.

The trapezoidal *vertical tail* consists of a fin with a small curved root fillet and a one-piece rudder. Sweepback at quarter-chord 21°34', aspect ratio 2.2, taper 2.88. The fin is a three-spar structure with a detachable leading edge; skin thickness 1.2 mm (0.047 in). Rudder skin thickness is 0.8 mm (0.03 in) at the leading edge and 0.6 mm (0.023 in) elsewhere.

The cantilever trapezoidal *horizontal tail* of similar three-spar construction consists of two stabilisers with detachable leading edges and one-piece elevators. Sweepback at quarter-chord 6°50', no dihedral, incidence –1°; aspect ratio 5.02, taper 2. The skin thickness is 1.0 mm (0.039 in) on the stabilisers and 0.8/0.6 mm on the elevators. Horizontal tail span 11.8 m (38 ft 8½ in); the effective horizontal tail area equals 17.38% of the wing area.

Landing gear: Hydraulically-retractable tricycle type, with free-fall extension in emergency; all three units retract forward. The levered-suspension steerable nose unit is equipped with twin 700 x 250 mm (27.55 x 9.84 in) K-275/M non-braking wheels.

The main units retract into the inboard engine nacelles; they feature four-wheel bogies which are tilted into vertical position (nose up) before retraction to lie inverted beneath the engines when retracted. The bogies have 930 x 305 mm (36.61 x 12.0 in) KT-81/3 wheels equipped with five-disc brakes and an anti-skid unit. A non-retractable faired tail bumper is installed on the rear fuselage underside.

The nosewheel well is closed by twin lateral doors and two small doors in line with the gear fulcrum; there are two small cutouts immediately aft for the nose gear jury struts which are sealed after retraction. Each main unit has two large main doors, two small clamshell doors in line with the gear fulcrums and two more small door segments for the aft-mounted drag strut. The large wheel well doors open only when the gear is in transit.

All landing gear struts have oleo-pneumatic shock absorbers and scissor links. The steerable nose unit controlled by a separate handwheel on the captain's control column can turn ±43° for taxying and is equipped with an RDM-1 steering mechanism/shimmy damper.

Powerplant: (IL-18V) Four Ivchenko AI-20 Srs 2 engines or, from Batch 20 onwards (mid-1960), identically rated AI-20A (AI-20 Srs 3 or AI-20 Srs 4) engines or, from Batch 65 onwards (August 1963), AI-20K (AI-20 Srs 5) engines which also power the IL-18E. Take-off power 4,000 ehp, maximum power at 8,000 m (26,250 ft) 3,180 ehp; nominal (maximum continuous) power 2,800 ehp at 8,000 m.

The IL-18B was powered by identically rated AI-20 Srs 1 or, from Batch 14 onwards (August 1959), AI-20 Srs 2 engines. The IL-18D is powered by AI-20M (AI-20 Srs 6) engines with a take-off rating of 4,250 ehp, a maximum power rating at 8,000 m (26,250 ft) of 3,420 ehp at 8,000 m and a nominal power rating of 2,980 ehp at the same altitude.

The AI-20 is a single-shaft turboprop with an annular air intake, a 10-stage axial compressor, an annular combustion chamber, a three-stage uncooled turbine and a fixed-area jetpipe with a conical centrebody. Power is transmitted via a planetary gearbox with a reduction ratio of 0.08732. Engine pressure ratio 9.2, mass flow at take-off rating 20.7 kg/sec (45.6 lb/sec), turbine temperature 1,173°K.

Specific fuel consumption (AI-20M) 0.243 kg/hp·h (0.53 lb/hp·h) at take-off rating and 0.197 kg/hp·h (0.43 lb/hp·h) in cruise mode.

Construction is of steel and magnesium alloy. The spool rotates in three bearings: a roller bearing in the air intake assembly (with an extension shaft to the reduction gear), a ball thrust bearing and a roller bearing in the combustion chamber casing. The air intake assembly has inner and outer cones connected by six radial struts and is de-iced by engine bleed air. The combustion chamber has ten burner cones, with igniters and pilot burners at the top.

Two accessory gearboxes (dorsal and ventral) are provided, the accessories proper being mounted on the forward casing.

The pressure-feed lubrication system uses a 75/25% mixture of MK-8 grade oil and MS-20 or MK-22 grade oil.

The AI-20 is started by twin STG-12TMO-1000 starter-generators using DC power from the APU or a ground power source; time from initiation to ground idling rpm is 70 seconds. SPN-4 igniters are provided for engine starting. Operational ambient temperature limits are –60°/+50° C (–76°/+122° F). The engines are controlled by means of a centrally mounted bank of throttles and a system of cables which operates the FCUs and the fuel shutoff cocks.

The engines are mounted in individual nacelles attached to the upper surface of the inner wings. On the inboard nacelles the forward fairings incorporate ventral oil coolers with air intakes and airflow adjustment flaps; on the outer nacelles the oil coolers are located in the fixed rear portion just ahead of the wing leading edge.

The rear portions of the nacelles house long, gently curving jetpipes made of heat-resistant steel and feature dorsal generator cooling air intakes and removable access panels. The engines are separated from the jetpipe bays and, in the case of the inner engines, from the mainwheel wells by titanium firewalls. There are gaps between the jetpipes and the wing upper surface allowing cooling air to pass.

The engines drive AV-68I Srs 02 or AV-68I Srs 03 four-blade variable-pitch constant-speed propellers; diameter 4.5 m (14 ft 9⅛ in), weight 370 kg (815 lb). The propellers are equipped with spinners.

Power is adjusted by altering the propeller pitch (blade settings vary from 0° for start-up on the ground through 83°30' in fully feathered position; the coarsest pitch used in flight is 55°, and the reverse thrust setting for slowing the aircraft after touchdown is 12°). Blade pitch is adjusted hydraulically. There are several automatic and manual propeller feathering systems featuring hydraulic, electric or pneumatic actuation. The propeller blades feature electric de-icer cuffs.

A TG-16M APU is installed in the No.3 baggage compartment for self-contained engine starting and ground power supply. The APU consists of a 100-shp GTD-16 gas turbine and a GS-24A starter-generator driven via reduction gear; it is enclosed by a protective cowling and draws air from the compartment itself.

Control system: Conventional mechanical dual control system with push-pull rods made of duralumin pipes, control cranks and levers (everywhere except for the aileron control circuit where cables and rollers are used to transmit inputs from the control wheels to the push-pull rods). Cables and rollers are also used to actuate the elevator trim tabs.

The system includes an AP-6E autopilot. The autopilot servos are connected to the control runs in parallel by means of cables and may be disengaged pyrotechnically at the push of a button if they jam. The servos feature overriding clutches, allowing the pilots to take corrective action when the autopilot is engaged.

Roll control is provided by two-section ailerons on the outer wings occupying 35.3% of the span. The ailerons have both aerodynamic and mass balancing; maximum deflection is ±20°. The inboard section of the starboard aileron features a trim tab actuated by an MP-100MT electric drive.

Pitch control is provided by one-piece elevators with aerodynamic and mass balancing which account for 40% of the effective horizontal tail area. Maximum deflection is +15°/–24°30'. Each elevator is equipped with a manually controlled trim tab.

Directional control is provided by a one-piece rudder. The rudder is likewise aerodynamically balanced and mass-balanced and features a spring-loaded servo tab at the root, with a trim tab actuated by an MP-100MT electric drive above it. Maximum deflection is ±25° for the rudder, ±9° for the trim tab and ±15° for the servo tab.

Fuel system: 22 fuel tanks with a total capacity of 23,700 litres (5,214 Imp gal). Bag-type tanks made of kerosene-proof rubber are housed in special containers in the inner wings, except the wing centre section (inside the fuselage). The fuel cell containers have removable ventral access panels. The outer wing torsion boxes serve as integral tanks holding 3,300 litres (726 Imp gal) each. Normally the port and starboard halves of the fuel system are isolated, but the system features a cross-feed valve.

The IL-18D features a 6,300-litre (1,386 Imp gal) integral tank in the wing centre section torsion box increasing overall fuel capacity to 30,000 litres (6,600 Imp gal) and the fuel load to 23.5 tons (51,900 lb).

The engines on each wing are fed by paired PNV-2 delivery pumps in the service tanks (Nos 1); if one fails, the other pump can still provide adequate delivery. Fuel system operation is automatic, but the transfer pumps can also be activated manually.

The IL-18 has two-point pressure refuelling, with a standard refuelling connector on the right-hand side of each mainwheel well near the main gear fulcrums (the large main gear doors have to be opened for access). Refuelling by gravity is also possible via three filler caps on each wing (tanks Nos 10, 6 and 8).

Electrics: The electrical system serves for engine starting and operates the avionics, equipment and part of the de-icing system, fuel system components and so on.

Main DC power (27 V) is supplied by eight 12-kilowatt STG-12TMO-1000 engine-driven starter-generators. If two generators fail or an engine is shut down, the remaining six generators are sufficient to serve all DC-powered equipment. Backup DC power is provided by three 12SAM-28 lead-acid batteries.

115 V/400 Hz single-phase AC for the propeller and windshield de-icers is supplied by four eight-kilowatt SGO-8 or 12-kilowatt engine-driven SGO-12 synchronous generators and a PO-1500 AC converter. 36 V/400 Hz three-phase AC for the radar, compass system, autopilot, Put'-4M navigation system, NAS-1B autonomous navigation system and artificial horizon is supplied by two (main and backup) 1-kilowatt PT-1000TsS AC converters at frame 8 in the forward avionics bay.

DC power is distributed via four distribution panels in the inner and outer engine nacelles, a rear distribution panel (between frames 65-67 to port) and circuit breaker panels in the flightdeck and galley. The

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A quartet of immaculate IL-18Vs at Moscow-Sheremet'yevo (the old terminal on the north side which is now Sheremet'yevo-1) in the mid-1960s. A PAZ-652 bus has just brought a load of passengers to CCCP-75772 (c/n 181003601), probably a Leningrad Civil Aviation Directorate/1st Leningrad United Air Detachment/67th Flight machine.

buses of the inboard distribution panels supply DC power to all equipment in the fuselage via two cables each to maximise reliability. AC power is distributed via a distribution panel in the ventral electrics bay and a circuit breaker panel in the flightdeck.

On the ground electric power is supplied by the batteries and the APU which drives a TS-24A starter-generator. Four ground power receptacles are provided.

Hydraulics: The hydraulic system operates the landing gear, nosewheel steering mechanism, wheel brakes, propeller feathering actuators and windshield wipers. It features two NP-25-5 pumps with a 40 litres/min (8.8 gal/min) delivery rate driven by the inboard engines, a 48-litre (10.56 Imp gal) hydraulic reservoir, a drain tank, two hydraulic accumulators for the general system in the mainwheel wells and two separate hydraulic accumulators for the wheel brakes (normal braking system) in the nosewheel well.

The system uses AMG-10 oil-type hydraulic fluid (*aviatsi**on**noye* ***mah**slo* *ghidrav**lich**eskoye*); total system capacity 75 litres (16.5 Imp gal), nominal pressure 210 kg/cm² (3,000 psi).

Nitrogen system: The nitrogen system serves for emergency wheel braking and emergency propeller feathering/engine shutdown. It features a 12-litre (2.64 Imp gal) bottle pressurised at 150 kg/cm² (2,140 psi) for the brakes in the nosewheel well and a 3-litre (0.66 Imp. gal.) bottle pressurised at 65 kg/cm² (≈ 930 psi) for the propeller feathering circuit in the No.1 baggage compartment.

De-icing system: The wing and tail unit leading edges, propeller blades and spinners, pitot heads and flightdeck windscreen panels have electric de-icing; the windscreen temperature is automatically maintained at +35°C (+95°F). Most of the electric de-icers operate on DC power, with the exception of the heated windshield and propeller blade/spinner de-icers which use 115 V AC. The engine air intakes, inlet guide vanes and oil coolers are de-iced by engine bleed air.

Oxygen system: The oxygen system normally serves the co-pilot only; the other crew members use it only in an emergency. Portable oxygen bottles with KP-21 breathing apparatus are provided in the event that any of the passengers should feel unwell.

Fire suppression system: Six 8-litre (1.76-Imp. gal.) OS-8 fire extinguisher bottles (three on frame 1 of each inboard engine nacelle which is the firewall); on aircraft manufactured from 1963 onwards they were augmented by ten 2-litre (0.44 Imp gal) OS-2-IL fire extinguisher bottles. The system is designed to fight fires in the engine nacelles, inside the engines proper and in the No.3 baggage compartment/APU bay. Impact sensors are installed on the underside of the inboard engine nacelles to trigger all fire extinguishers automatically in a wheels-up landing.

The aircraft is equipped with an SSP-2A fire warning system providing audio and visual warnings. Portable CO_2 fire extinguishers are provided for fighting fires in the cabin and flightdeck.

Air conditioning and pressurisation system: The IL-18 features a ventilation-type pressure cabin pressurised by engine bleed air to a pressure differential of 0.5 kg/cm² (7.14 psi). Sea level pressure is automatically maintained up to 5,200 m (17,060 ft) in order to keep the passengers comfortable.

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Above: The specially modified Polar Aviation IL-18V CCCP-75743 (c/n 181002901) was the first *Coot* to perform an ultra-long-range mission to Antarctica. Here it is seen in the late red-tailed colour scheme in which it flew from Moscow to Ice Station Mirnyy and back on 15th December 1961 – 2nd February 1962 together with the An-12TP-2. The wing of the latter aircraft (CCCP 04366) is visible in the foreground.

At 8,000 m (26,250 ft) the pressurisation system maintains a cabin pressure equal to 1,500 m (4,900 ft) above sea level; at 10,000 m (32,800 ft) the cabin pressure equals 2,400 m (7,870 ft) ASL.

The air is cooled by heat exchangers located in the wing roots and humidified before being distributed through the pressure cabin. The system can be adjusted to automatically maintain the cabin temperature anywhere between +5° and +20°C (+41 to +68°F). The cabin air is completely exchanged up to 30 times per hour.

Avionics and equipment: The IL-18 is fully equipped for all-weather day/night operation, including automatic flight assisted by an autopilot.

Navigation and piloting equipment: The navigation suite includes an RPSN-2AMG or RPSN-2N Emblema weather radar with a secondary traffic collision avoidance system (TCAS) function, an NAS-1B autonomous navigation system, a Put'-4M (Way-4M) navigation system, a KS-6G compass system, a DAK-DB remote celestial compass, an RSBN-2S Svod (Dome) short-range radio navigation (SHORAN) system with flush antennas built into the fin, an SP-50 Materik ILS, an RV-UM radio altimeter with dipole aerials under the stabilisers, an NI-50BM-1 navigation display, main and backup ARK-11 automatic direction finders (each with a buried loop aerial and a ventral strake aerial under the wing centre section) etc.

The radar set of the RPSN-2 is located at frame 4 on the port side; there are two radar displays (for the pilots and the navigator). The NAS-1B autonomous navigation system comprises a DISS-1 Doppler speed/drift sensor system with a flat rectangular antenna under the rear fuselage and an ANU-1 autonomous navigation computer. The SP-50 includes a KRP-F localiser receiver, a GRP-2 glideslope beacon receiver, an MRP-56P marker beacon receiver with an aerial under the wing centre section, and a module for working with Western ILS beacons.

Communications equipment: One RSB-5/1230 communications radio, two RSIU-5 (R-802G) command link radios and a 1-RSB-70 backup communications/command link radio. The RSB-5/1230 and 1-RSB-70 radios were served by a wire aerial running from frame 4 to the fin top and a dorsal strake aerial (the latter was later removed and replaced by a blade aerial on the forward fuselage). The main RSIU-5 has a ventral 'hockey stick' aerial between frames 11-12, while the backup RSIU-5 uses an aerial built into the dielectric fin cap.

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IL-18D CCCP-74267 (c/n 187011105) in 1973-standard red/white Polar colours at the Soviet Ice Station Molodyozhnaya in Antarctica in February 1980.

An SPU-7 intercom and an SGU-15 public address system with 15 loudspeakers in the cabins and two in the flightdeck are provided for communication between crew members and crew-to-passengers communication.

IFF system: SRO-2 or SRO-2M Khrom (Chromium) IFF transponder. The characteristic triple IFF aerials serving one of the wavebands are located ahead of the flightdeck glazing and under the aft fuselage four other IFF antennas are located on the sides of the nose and the tailcone.

The aircraft also features an ATC transponder with aerials inside the radome, on the tailcone and in the fin (a flush antenna located above the SHORAN antennas).

Data recording equipment: MSRP-12-96 primary flight data recorder (FDR) (later replaced by an MSRP-64B FDR), K-3-63 backup FDR and MS-61B cockpit voice recorder (CVR).

Exterior lighting: Port (red) and starboard (green) navigation lights, two at each wingtip (SM-21M lights at the leading edge and BANO-45 lights at the trailing edge); KhS-57 white tail navigation light on the tailcone. Retractable FRS-200 landing/taxi lights on the sides of unpressurised part of the nose (frames G-D) and under the wingtips. Red SMI-2 anti-collision strobe lights under the rear fuselage and at the top of the fin; the lights flash sequentially at one-second intervals.

Accommodation: The flightdeck is configured for a crew of five, with the navigator's workstation on the left and the radio operator's station on the right. The flight engineer sits on a fold-away chair between and behind the pilots.

The IL-18V can be configured with various seating arrangements from 84 to 127 passengers featuring first class (F), tourist class (CY) and economy class (Y) seating. Possible layouts include:

- a 73-seat mixed-class layout (CY20+CY45+F8) featuring five-abreast seating at 90 cm (35⅜ in) pitch in the forward cabin and 102 cm (40 in) pitch in the centre cabin and two four-abreast rows of sleeperette seats at 112 cm (44 in) pitch in the rear cabin;
- a similar 78-seat mixed-class layout (CY20+CY50+F8) with 90 cm seat pitch in the centre cabin;
- an 84-seat tourist-class layout with 20+50+14 seats at 90 cm pitch in all three cabins;
- an 89-seat tourist-class layout with 20+55+14 seats, the extra row in the centre cabin being introduced by reducing the pitch to 84 cm (33 in);
- a 105-seat all-economy layout with 24+65+16 seats at 84 cm pitch, the extra capacity being obtained by shrinking the galley and reconfiguring the rear cabin;
- a 110-seat mixed-class layout (Y24+Y72+CY14);
- a so-called 'winterised' 110-seat layout (Y24+Y72+CY14) featuring larger coat closets and a larger galley at the expense of reducing the seat pitch;
- a 111-seat all-economy layout with 24+71+16 seats;
- a 127-seat mixed-class layout (Y24+Y89+CY14) with reduced coat closets and a small galley.

With five-abreast tourist class seating the seats are 45 cm (17¾ in) wide (measured between the armrests) and the aisle width is likewise 45 cm. With six-abreast economy class seating it is 41.5 cm (16⅜ in) and 35 cm (13¾ in) respectively.

All IL-18Vs *et seq.* in regular airline configuration are equipped with three toilets. Most layouts feature three coat closets.

In VIP configuration (IL-18V 'Salon') the aircraft provides accommodation for 35-50 passengers. The 35-seat IL-18V 'Salon' features two cabins for the retinue seating 20 and 14 respectively at 90 cm pitch, divided by the forward vestibule featuring a toilet and a coat closet to starboard and a refrigerator and a portable oxygen bottle rack to port. Further aft is a galley of reduced size; next is a VIP lounge (the so-called 'main passenger's cabin') equipped with a sofa, swivelling armchairs, tables, a sofa and a book closet. The rear vestibule with a coat closet separates this from a bedroom and toilet for the VIP at the extreme rear. Another configuration seated 34. There was a single row of four sleeperette seats immediately aft of the flightdeck, followed by an eight-seat compartment for a relief crew. Separated from these by the forward vestibule and the galley was a 14-seat tourist class cabin for the retinue (two rows of five seat and one row of four). Then came two VIP cabins, each with two armchairs facing each other (with a table in between) and a four-seat sofa across the aisle; two seats on the starboard side opposite the rear entry door (presumably for the bodyguards); and finally a bedroom featuring two more armchairs and a table.

The earlier IL-18B featured a different 89-seat tourist class layout with 19 seats in the forward cabin and a 70-seat main cabin. There was also an 80-seat tourist class configuration. The IL-18D was offered in 65-seat, 90-seat, 100-seat, 110-seat or 122-seat configurations.

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Above: The IL-18 was one of the Soviet Union's major export successes both on the airline market and for military uses. The latter is illustrated here by Polish Air Force IL-18V 'Salon' '102 Red' No.1 (c/n 181002701). The serial was later reused for IL-18E 'Salon' c/n 186008905.

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On the commercial market the IL-18 was supplied mostly to the Soviet Union's East European satellites and African nations. This is IL-18V DM-STG, the last example delivered to Deutsche Lufthansa (the East German domestic airline which existed until September 1963, that is!), during one of the leases to Interflug which was then a charter carrier. Note the combination of the DLH cheatline (with a characteristic 'horn' aft of the flightdeck) and DLH white tail with Interflug titles and logo.

The cabins feature lightweight seats; the seat backs recline at the push of a button in an armrest. The seats are provided with seat belts and detachable meal trays installed on the armrests

IL-18 in civilian service

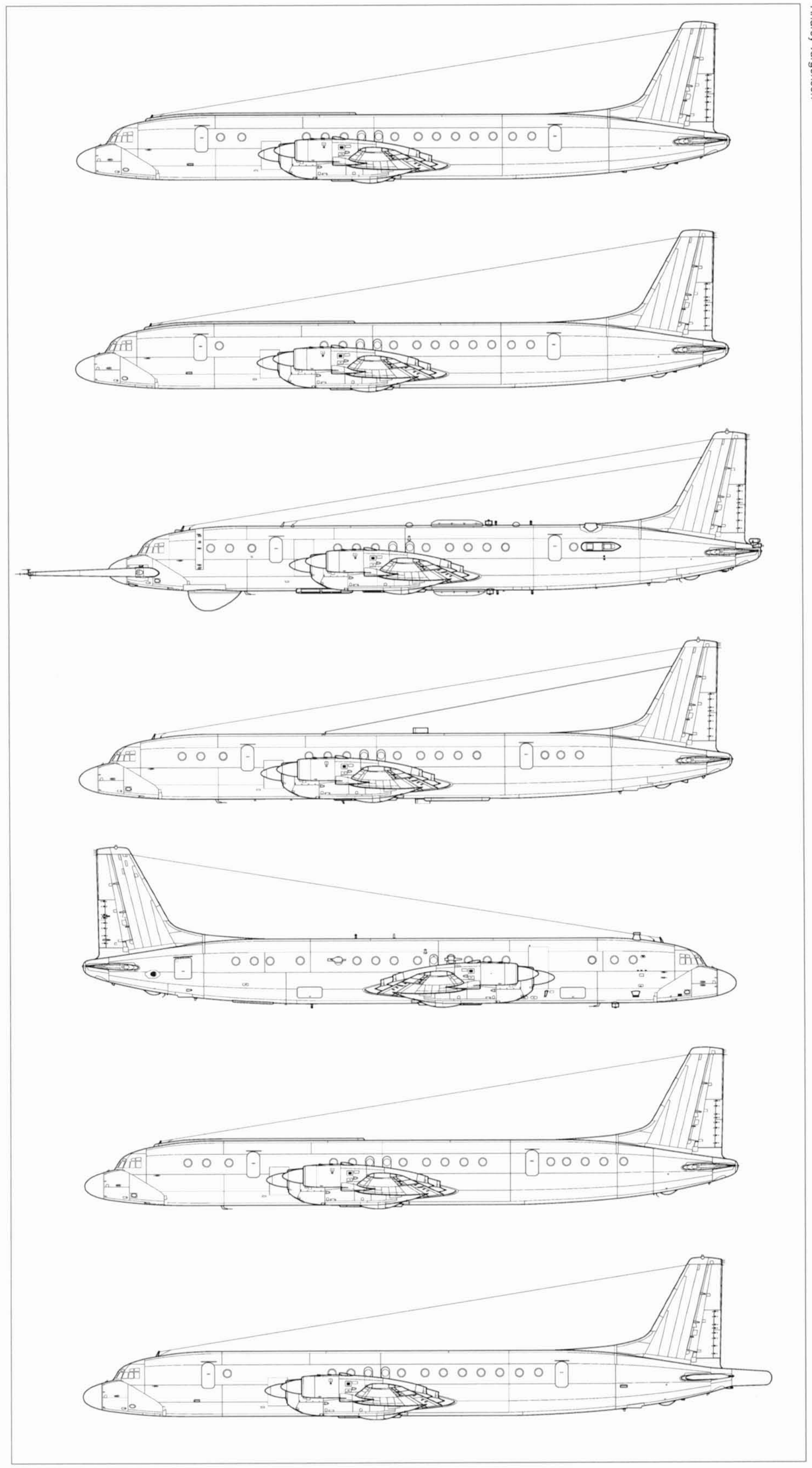
The IL-18's service career with Aeroflot started in January 1958 when the Vnukovo UAD of the Moscow Territorial CAD began route proving flights with a handful of IL-18As. For safety reasons the *Coots* initially carried only freight and mail.

Revenue services finally started on 20th April 1959; two scheduled passenger flights were performed on the opening day, these being flights from Moscow to Adler (a popular Black Sea resort) and to Alma-Ata, the capital of the Kazakh Soviet Socialist Republic. Domestic flights were soon followed by international services. The first scheduled flight abroad by an IL-18 took place on 5th January 1960; it was a flight from Moscow to Sofia. In January 1962 the IL-18 was put on the Moscow-Jakarta service; in June of that year the type began to be operated on the route from Moscow to Accra (Ghana) via Rabat (Morocco), Bamako (Mali) and Conakry (Guinea).

The IL-18 turned into one of the Soviet Union's major export successes among commercial aircraft. Starting in November 1959, the Soviet agency Aviaexport delivered new or used IL-18s to 20 nations located as far apart as China, Cuba and Ghana.

The IL-18 became the most widespread Soviet airliner in its weight and capacity category, with a production run of 565 (that is, not counting the specialised military versions) – a figure which was subsequently bettered by the Tu-154, but that was much later. Of these, about 420 units were delivered to Aeroflot alone (again, not counting Air Force and industry-operated IL-18s in Aeroflot markings). In Soviet times the IL-18 saw service with civil aviation divisions in ten of the Soviet Union's fifteen republics.

In comparison with the piston-engined Li-2, IL-12 and IL-14 aircraft the turboprop IL-18 offered much more comfortable transportation in 50% less time. This was duly appreciated by passengers. The aircraft was also popular with the pilots for its easy handling and ability to tolerate piloting errors. The early years of IL-18 operations were beset by technical problems, associated, in particular, with the low reliability of the AI-20 engines and of the propeller feathering mechanism. On several occasions severe engine fires or the impossibility to feather a dead engine's propeller resulted in fatal



Andrey Yurgenson

Top to bottom:
An early-production IL-18B pertaining to batches 5-11 (with two windows aft of the forward entry door);
a late-production IL-18B pertaining to batches 13-16 (with a single window aft of the forward entry door);
the IL-18D 'Tsiklon' weather research aircraft;
the L-18DORR fishery reconnaissance aircraft;
the IL-18E 'Meteor' weather research aircraft;
the IL-18I experimental long-haul airliner; the IL-18RT range instrumentation/telemetry relay aircraft.

crashes. However, the OKB and the factory did their best to rectify the airliner's faults. In due course, the powerplant and avionics worked up an adequate reliability level and the IL-18 gained a well-earned reputation as 'the most dependable airliner' – especially in comparison with the Tu-104 and An-10.

Gradually, the IL-18 became Aeroflot's principal medium/long-haul airliner. In 1970 the type shouldered 39.8% of the passenger air traffic in the Soviet Union, and this situation continued until 1975. The IL-18 was also the most cost-effective Soviet airliner in its class, having the lowest operating costs among comparable Soviet aircraft. The *Coot* ranked first among Soviet airliners in the same class as far as non-stop range was concerned, the IL-18D being capable of a range of 4,500-6,500 km (2,795-4,040 miles).

In addition to airline service, the IL-18 was delivered to the Soviet Air Force and the Naval Air Arm – mostly in the VIP aircraft role, often with additional secure communications equipment. Likewise, the type served with the Soviet federal government flight (the 235th IAD) for VIP transportation.

The IL-18 also made an invaluable contribution to the exploration of Polar regions and the development of the Soviet Union's sparsely populated northern and north-eastern regions. Aeroflot's Polar Aviation Directorate received its first IL-18s in 1959. This type gained wide publicity after several missions flown by the IL-18s to Antarctica for the purpose of delivering fresh teams of researchers to Soviet Antarctic stations. The first such expedition took place in December 1961-January 1962. The IL-18s performed resupply and (occasionally) research flights to Antarctica on a regular basis until 1986 when the mission was taken over by the more capable IL-76TD freighter. In addition, the IL-18s flew scheduled flights from Moscow to a number of destinations beyond the Arctic Circle on the Soviet territory.

Mention should be made of the use of the IL-18 in various special operations, such as the United Nations airlift to Congo in 1960, troop rotation missions for the Soviet Army contingent in Afghanistan (during the Afghan War) and to Eastern Europe where Soviet troops were deployed. The IL-18 was often used for humanitarian airlift missions.

Finally, mention must be made of a series of world records established by this aircraft. Even before its entry into airline service the IL-18 established a series of world altitude records for turboprop aircraft. For example, on 14th November 1958 the third production IL-18A (CCCP-Л5820, c/n 187000103) captained by Ilyushin OKB chief test pilot Vladimir K. Kokkinaki climbed to 13,154 m (43,156 ft) with a 10-ton (22,045-lb) payload. These were followed by a string of world speed records with different payloads. On 19th August 1959 IL-18A CCCP-Л5820 flying along a 2,000-km (1,242-mile) closed circuit with a payload of 1, 2, 5, 10 and 15 tons (2,205; 4,410; 11,020; 22,045; 33,070 lb) clocked a speed of 719.496 km/h (446.892 mph). These achievements were supplemented by range records. For example, in October 1967 an IL-18 (piloted, incidentally, by a female crew) covered an impressive distance of 7,661.949 km (4,758.97 miles) flying in a straight line from Simferopol via Moscow to Magadan.

Summing up, it can be said that the IL-18's sturdy design, performance and good operating economics (even by modern standards) account for its rare longevity. The *Coot* was, and still is, a true workhorse designed to do its job anywhere and in any environment. In the first 20 years after the type's service introduction the IL-18 fleet logged a total of more than 12,000,000 flight hours, making nearly 5.5 million flights and carrying 235 million passengers. The IL-18 was Aeroflot's only type to achieve individual aircraft total times of 35,000 hours in passenger configuration and 40,000 hours in cargo configuration.

IL-18: Dedicated military versions

Predictably, the IL-18 quickly found military uses as well. Apart from the obvious VIP transport role and the military airlift reserve function fulfilled by Aeroflot's regular fleet, the IL-18 evolved into several specialised versions for the Soviet Air Force and the Soviet Naval Air Arm. These are described below.

IL-18TD troopship

As early as 18th December 1958 the Council of Ministers had issued a directive ordering the development of the IL-18T military transport version described earlier. In medevac configuration the aircraft was to carry 69 casualties on stretchers, while the paradrop configuration was to take 118 assault troopers and two instructors.

However, for some reason the idea did not materialise until ten years later. In 1968 a single IL-18D (CCCP-74296, c/n 188010603) was converted experimentally into a troop carrier aircraft designated IL-18TD (***trahns**portno-de**sahnt**nyy* – transport/paradrop, used attributively). The cabin featured tip-up seats along the walls and steel cables for hooking up the paratroopers' static lines.

Yet the Soviet Air Force decided it did not want a slow turboprop capable of paradropping only personnel. The project was abandoned and CCCP-74296 was reconverted to a standard IL-18D; in post-Soviet days it was operated by the now-defunct Tret'yakovo Aircompany in IL-18Gr cargo configuration as RA-74296.

Dmitriy Komissarov

IL-18V RA-75840, one of the four *Coots* operated by now-defunct IRS Aero, begins its take-off run from Zhukovskiy's runway 12 on 13th August 2001, one day before the opening of the MAKS-2001 airshow. Just over three months later, on 19th November, this aircraft crashed near Tver', Russia, killing all on board.

IL-18B airborne command post/staff transport version

Shortly after completing State acceptance trials at GK NII VVS the aforementioned IL-18B CCCP-75666 (c/n 188000705) was delivered to the Soviet Air Force and outfitted as an airborne command post (ABCP) or staff transport. The new role was revealed by several additional blade aerials associated with secure HF communications system.

IL-18V airborne command post/staff transport version

Three Soviet Air Force IL-18Vs – CCCP-75516 (c/n 183006604), CCCP-75602 (c/n 182004203) and CCCP-75606 (c/n 182004405) – were converted into ABCPs. The aircraft sported two identical sets of additional blade aerials (one small aerial followed by two large ones) located symmetrically above and below the forward fuselage just aft of the nose gear. No separate designation is known for this version.

The aircraft were based at Chkalovskaya AB east of Moscow, serving with the 8th Special Mission Air Division (8th ADON – ***avia**di**veeziya osobovo naznacheniya*); later, they were operated by the 223rd Flight Detachment, an airline under Russian Air Force management.

IL-18D airborne command post/staff transport version

Two Soviet Air Force IL-18Ds – CCCP-75478 (c/n 189011302) and CCCP-75496 (c/n 185011303) – were fitted with a different HF communications gear suite, which also qualifies them as ABCPs. In reality, however, they were primarily systems and avionics testbeds for the purpose-built IL-22 *Coot-B* described later. These aircraft featured a small strake with communications antennas extending forward from the fin fillet and were equipped with a powerful TA-6 APU installed in similar fashion to the IL-22 instead of the standard TG-16; the latter was due to the fact that the APU doubled as an extra generator powering the mission equipment. Again, both aircraft served with the 8th ADON; later they had the mission equipment removed (the TA-6 APU was retained) and now belong to the 223rd Flight Detachment.

Another IL-18D (CCCP-75498, c/n 187009804) in early Aeroflot colours and equipped with a standard TG-16 APU had a set of blade aerials similar to the IL-18Vs described above and a non-standard window arrangement: 3+door+3+2 exits+1+4+door+3 on the port side and 3+3+2 exits (the rear one had a 'solid' cover minus window)+1+3+1+3 to starboard. Later the aerials were removed and the aircraft was repainted in 1973-standard Aeroflot colours. It also went on to serve with the 8th ADON/223rd Flight Detachment as RA-75498.

IL-18RT range instrumentation aircraft

Two quasi-civil IL-18Vs – CCCP-75528 (c/n 183006901) and CCCP-75840 (c/n 182005301) – were converted into a telemetry relay version designated IL-18RT (*retrans**lya**tor* – relay installation) by LNPO Leninets at the flight test facility in Pushkin. The date of the conversion is unknown but CCCP-75840 had been in service with the Naval Air Arm since 10th February 1965, having been transferred from the Moscow Territorial CAD/Vnukovo UAD/65th Flight.

The aircraft's mission was to relay telemetry data from prototype missiles and unmanned aerial vehicles to ground control stations. The IL-18RT could be identified by a thimble-shaped dielectric fairing on a special adapter supplanting the standard tailcone and prominent cigar-shaped fairings at the ends of the horizontal tail; these housed receiver and transmitter antennas. Additionally, CCCP-75840 featured a small elongated fairing low on the port side of the forward fuselage near the nose gear unit and small blister fairings like the SL-18 avionics testbed series on the aft fuselage sides. According to some sources, the IL-18RTs supported the Soviet space programme together with the later IL-20RTs (see below).

Yefim Gordon

Above: Russian Air Force IL-20M '90 Red' (c/n 173011501) at Shaikovka AB.

Some sources say the first IL-18RT is still operated by the Russian Navy's Pacific Fleet as RA-75523 in transport configuration. The second aircraft was reregistered RA-75840, serving with the 240th GvOSAP (*Gvar**dey**skiy **otdel**'nyy **smesh**annyy **avia**polk* – Guards Independent Composite Air Regiment) which was part of the Russian Naval Aviation Combat & Conversion Training Centre at Ostrov AB near Pskov. It was mostly operated not in its intended role as a proficiency trainer for the Centre's IL-38 crews so as not to waste the *Mays'* service life.

In 1998 RA-75840 was sold to the charter carrier IRS-Aero and the military avionics were removed in the course of refurbishment at ARZ No.20 which was completed on 30th September; the airline took delivery of the aircraft on 2nd October. The non-standard antennas vanished but the adapter for the tail radome remained, the aperture being closed by a blunt conical fairing. The resulting fat tailcone clearly identified RA-75840 as a former special mission aircraft. In this form the airliner flew in combi configuration until it crashed on 19th November 2001.

IL-20M ELINT aircraft (*izdeliye* 17)

This, chronologically the second dedicated military derivative of the IL-18 (after the IL-38), was actually the third aircraft to bear the service designation IL-20. As related in Chapters 1 and 2, the first IL-20 was a piston-engined ground attack aircraft of 1947 which proved disappointing and did not progress beyond the sole prototype stage. Later the designation was applied to a handful of demilitarised IL-28 tactical bombers which were used by the Soviet airline Aeroflot as mailplanes in the mid-1950s, carrying newspaper matrices to the eastern parts of the USSR.

The IL-20 started life on 23rd March 1965 when the Defence Industry Commission of the CofM Presidium (VPK – Voyenno-promyshlennaya komissiya) ruled that OKB-240 should develop an electronic intelligence (ELINT) aircraft based on the IL-18. The choice of the Ilyushin airliner as the starting point was dictated by much the same reasons as in the case of the civil special mission versions – the IL-18DORR fishery reconnaissance aircraft and IL-24N ice reconnaissance aircraft.

Yefim Gordon archive

The IL-20M ELINT aircraft is instantly recognisable by the ventral SLAR pod and lateral fairings. Note the mudguard on the nosewheels to avoid damaging the pod and the accordingly bulged nose gear doors.

The requirements applying to an ELINT platform are rather different from those applying to a 'traditional' photo reconnaissance (PHOTINT) aircraft. An electronic snooper generally does not have to overfly the target or get close to it. Thus there is little danger of being shot down, hence high speed/altitude performance and defensive armament are not prime requirements. What matters more is range and especially endurance, as well as sufficient internal volume to accommodate lots of mission equipment and a large team of equipment operators. That said, it is clear that the Soviet Air Force could hardly pick a better platform in the late 1960s – especially from a cost/effect standpoint.

The result was an airborne reconnaissance system with the in-house product code *izdeliye* 17 and the unclassified service designation IL-20M (*modifi**tsee**rovannyy* – modified); for some obscure reason there was never an 'IL-20 *sans suffixe*' version of the *Coot*. Apart from some minor changes associated with the aircraft's military role, the airframe was identical to that of the IL-18D which was the current (and final) production version of the civil *Coot* from 1966 onwards. However, an ELINT aircraft inevitably sprouts non-standard aerials and other 'bumps and bulges', often quite big ones. In the case of the IL-20M the most obvious recognition feature was a massive elliptical-section pod under the forward fuselage. This housed the antenna arrays of the Igla-1 (Needle-1; pronounced *ig**lah***) side-looking airborne radar – which, incidentally, was the Soviet Union's first phased-array radar.

The SLAR pod was mounted on a short pylon between fuselage frames 8 and 27; almost the entire bottom and sides were dielectric and could swing open for maintenance. The nosewheels were fitted with a large mudguard to protect the pod from flying stones and the nose gear doors were suitably bulged. The radar set was located in the former forward luggage compartment of the IL-18. The Igla-1 SLAR generated a radar image of the terrain lying at right angles to the direction of flight as far as the radio horizon and could pinpoint the location of such objects as bridges, dams, road junctions and so on.

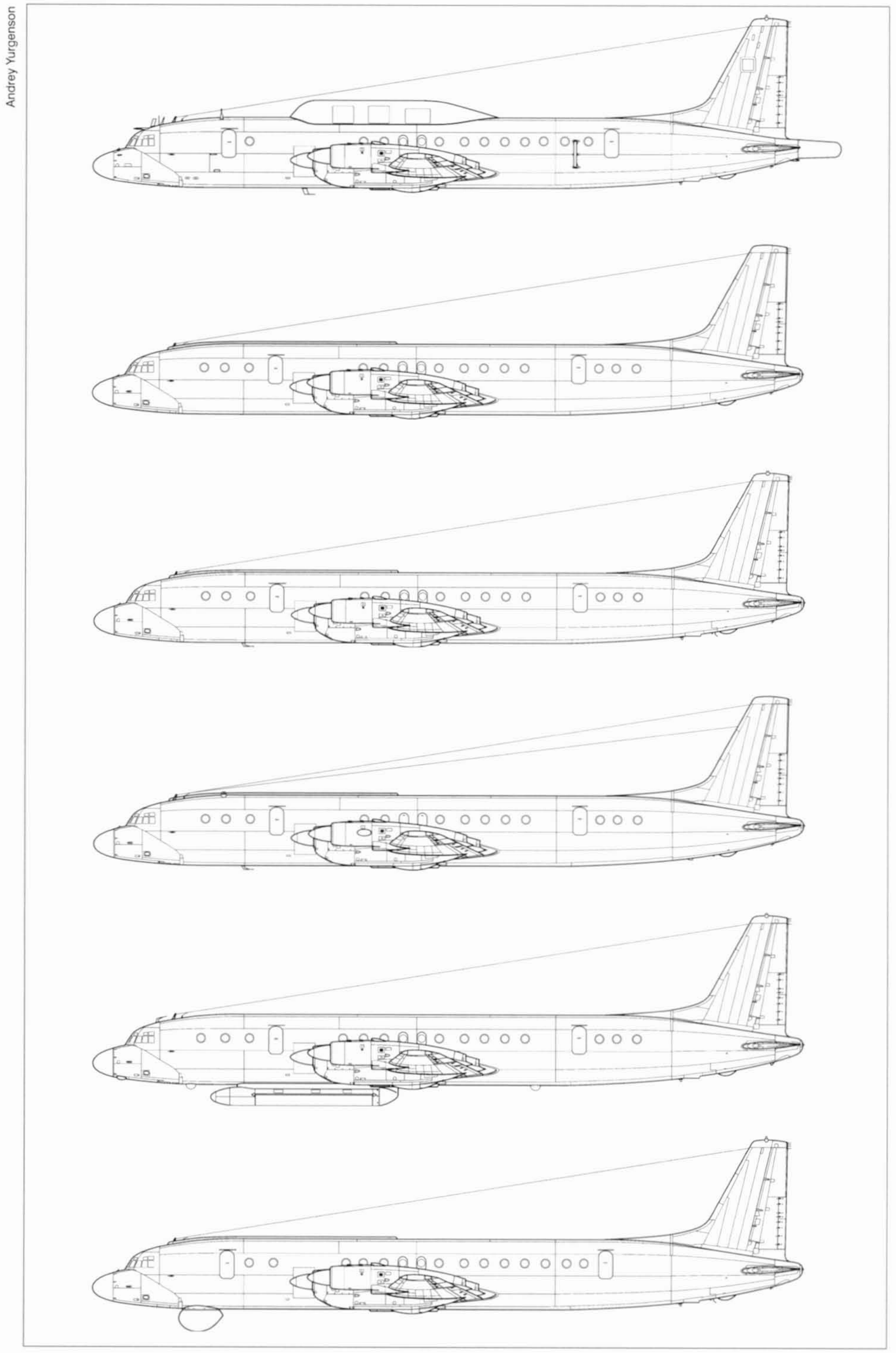
The IL-20M's imaging capabilities were not limited to SLAR. Two oblong, shallow slab-sided fairings were located on the forward fuselage sides under the forward cabin windows; their front portions incorporated ports for A-87P long-range operation (LOROP) oblique cameras which featured optically flat glass protected by sliding doors which remained closed most of the time. The cameras themselves were mounted in the forward cabin; hence the foremost cabin window on each side was omitted. The front end of the starboard fairing also incorporated a ram air intake for the SLAR's heat exchanger.

Yet the aircraft's primary mission was signals intelligence (SIGINT), notably detection of enemy radars across the border or in the frontline area, and the IL-20M was adequately equipped for this role. The greater part of the above-mentioned cheek fairings was dielectric, accommodating the antenna array of the Romb-4 (Rhomboid-4, or Diamond-4) general-purpose SIGINT system; the latter determined the enemy radar's bearing and operating frequency. Apart from that, the aircraft featured a *Kvad**raht**-2* (Square-2) detail SIGINT system with three square-shaped dielectric panels low on the fuselage sides aft of the wings (this detected bearing, operating frequency, pulse rate frequency, relative pulse duration, emission power and so on) and a ***Vish**nya* (Cherry) communications intelligence system. The latter's twin trapezoidal aerials mounted dorsally on the forward fuselage were another trademark feature of the IL-20M. Four small blade aerials were located under the aft fuselage. There were also three ventral blister radomes aft of the wings pertaining to an unidentified system.

The aircraft had a crew of thirteen: captain, first officer, flight engineer, navigator, radio operator and eight reconnaissance systems operators. Of these, only the camera operator sat in the forward cabin; the other seven workstations were in the back. The Vishnya COMINT system was worked by a specially trained operator who, besides a good knowledge of the appropriate foreign language, had to be well versed in military radio slang.

Multiple reconnaissance systems were used simultaneously to make sure accurate intelligence was obtained. For example, the radar imagery provided by the SLAR could be checked against detailed photographs provided by the cameras, while the information supplied by the Kvadraht-2 system could be matched with a radar map of the area generated by the SLAR.

The installation of the many mission equipment items necessitated some local reinforcement of the fuselage. Due to the aircraft's military role and the greatly reduced number of occupants most of the IL-18's cabin equipment (toilets, wardrobe, galley and so on) was deleted. Changes were made to the oxygen system; all crew seats were designed to accommodate a parachute, and an escape chute and hatch were provided on the starboard side of the aft fuselage where the rear baggage door used to be (a vestige of the door still remained).



Andrey Yurgenson

Top to bottom:
The IL-18SIP (IL-18RTL) range instrumentation/telemetry relay aircraft'
Early-production and late-production versions of the IL-18V;
The IL-18V-26 (IL-18D) long-range Polar supply aircraft;
The IL-24N ice reconnaissance aircraft;
The IL-18SL (SL-18A) avionics testbed as originally flown with the Berkut radar.

An IL-18D airframe was set aside at MMZ No.30 for conversion into the IL-20M prototype, and conversion work began on 6th May 1967. Almost a full year later the aircraft made its first flight from Moscow-Khodynka on 25th March 1968; the test crew was captained by Ilyushin OKB chief test pilot Stanislav G. Bliznyuk, while V. M. Volod'ko was the engineer in charge of the flight tests.

In July 1968 the prototype was very nearly lost during high-alpha trials. The basic IL-18 had passed such trials in its time but renewed trials were found necessary because the IL-20M's many equipment fairings altered the aircraft's aerodynamics considerably. Again the crew was headed by Bliznyuk. At extreme angles of attack the IL-20M got into a super-stalled position; losing altitude, it entered thick overcast and the crew became disoriented.

Still, Bliznyuk did not lose his presence of mind and, using his experience with fighters and a good deal of courage, managed to recover from this seemingly hopeless situation. For saving the aircraft and crew he received his first – and most cherished – Order of the Red Star.

From 4th to 10th April 1970 the IL-20M participated in the *Dvi**na*** military exercise; this was probably the type's service debut. Like the IL-38, the ELINT version had overt military markings. Curiously, many IL-20Ms carried no tactical code.

Low-rate production continued until 1976, totalling about 20 aircraft. IL-20 c/ns followed the pattern of the IL-18, starting at Batch 114, but commenced with 17 instead of 18 (for example, '21 Red', c/n 173011504).

The West did not become aware of the type's existence until 1978 when an IL-20M was intercepted by NATO fighters over the Baltic Sea. After that the type was code-named *Coot-A*. The actual designation took even longer to become known, and some Western sources erroneously referred to the aircraft as the IL-20DSR (***dahl'****niy strate*-***gich****eskiy raz****ved****chik* – long-range strategic reconnaissance aircraft).

The IL-20Ms flew very special and hush-hush missions, operating from bases along the Soviet borders (near Khabarovsk in the Far East, near Tbilisi in the South and so on). They were also deployed in the Soviet Union's Warsaw Pact allies in order to get closer to the 'potential adversary'; for instance, since the mid-1970s two *Coot-As* were seconded to the Group of Soviet Forces in Germany (renamed Western Group of Forces in 1989).

Due to the highly classified nature of their work the IL-20Ms were not listed on the inventory of regular reconnaissance regiments, reporting directly to the HQ of the Defence District or air army they were working for. The two examples stationed in East Germany were operated by an independent reconnaissance squadron at Sperenberg AB near Berlin which was part of the 16th VA (*voz**doosh**naya **ar**miya* – air army) stationed in East Germany; this unit has been reported as the 390th OAO (*ot**del'**nyy aviatsi**on**nyy ot**ryad*** – independent flight detachment). In 1978 they were briefly deployed to Oranienburg AB. Remarkably, they remained at Sperenberg long after German reunification on 3rd October 1990; the last IL-20M departed for Levashovo AB near St. Petersburg on 21st June 1994.

The IL-20M can be regarded as the Soviet answer to the Boeing RC-135 series, albeit the *Coot-A* could not equal its American counterpart in speed and range, having no aerial refuelling capability.

IL-20M upgrades and conversions

By mid-1999 GK NII VVS had outfitted one of the IL-20Ms ('90 Red', c/n 173011501) with an upgraded mission equipment suite. The modified aircraft lacked the rear trapezoidal aerial of the Vishnya COMINT system, while the two rearmost ventral blister radomes were replaced with a largish square-shaped ventral 'bathtub'. Even more unusually for a *Coot-A*, it carried a civil registration, RA-75923 – despite the fact that an IL-22M-11 *Coot-B* airborne command post with the same registration (c/n 187010305) already existed (see below)! The reason for this duplication may be that the IL-22 in question was already retired by then and, while the aircraft itself still existed, the registration may have been cancelled years before and then reused.

The existence of the new variant came to light on 15th August 1999 when Chkalovskaya AB was open to the general public on Aviation Day (the third Sunday in August). Though not part of the official static display, IL-20M RA-75923 No.2 was parked on the 8th ADON flight line which the visitors were able to examine, while RA-75923 No.1 was standing engineless on the grass no more than 100 m (330 ft) away! However, in mid-2002 the dead IL-22M-11 was finally broken up, leaving IL-20M c/n 173011501 as the only RA-75923 in existence.

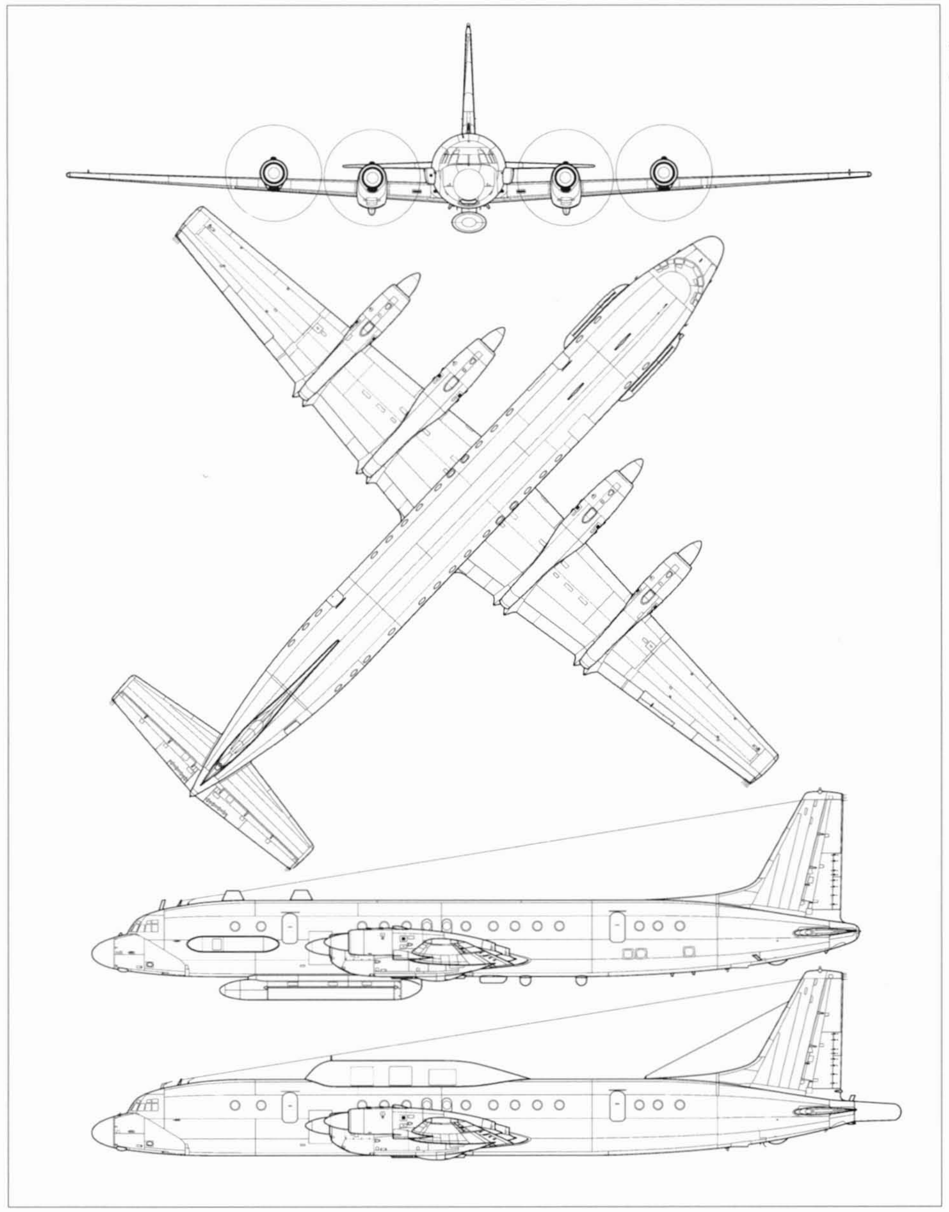
For some reason two IL-20Ms manufactured in 1972 were stripped of all mission equipment and associated fairings and converted to passenger configuration (or perhaps even built as such to fill a special order due to the unavailability of new-production IL-18s). The first aircraft (c/n 172011401) was sold to the Ukrainian carrier Lviv Airlines in 1999 and registered UR-BXD. It wore 'IL-18D' nose titles but the two windows in the forward cabin instead of three and the vestigial No.2 baggage door (not to mention the c/n) gave it away.

The other aircraft (c/n 172011402) was entered into the Soviet civil register as CCCP-75903, albeit an IL-22 ABCP with the same registration (c/n 0393610235) already existed! (The registration date is quoted as 2nd February 1988, which automatically makes it the second aircraft to have this registration because IL-22 production had ended by then.) On the other hand, IL-20 CCCP-75903 No.2 was the first to receive the Russian prefix in 1994, and it was another four years before IL-22 **CCCP**-75903 **No.1** became **RA**-75903 **No.2**.

IL-18SIP (IL-18RTL) and IL-20RT telemetry and communications relay aircraft (*izdeliye* 17)

The IL-18 – or, to be precise, the IL-20 – even participated in the Soviet space programme. When space vehicles are launched the operation of their systems is monitored by means of telemetry. At some stages of the flight, however, it is not possible to collect telemetry data using ground stations or space tracker ships; a suitably equipped aircraft becomes the only option. Hence on 28th September 1970 the Soviet Council of Ministers issued a directive concerning the development of the IL-20RT space tracker/telemetry and communications relay aircraft based on the *Coot-A*. Once again the RT stood for *retrans**lya**tor* – relay installation. The first aircraft was to be completed by August 1972.

Outwardly the IL-20RT had nothing in common with the similarly designated IL-20M ELINT aircraft as far as 'bumps and bulges' are concerned. To test the space tracker's mission avionics LII converted IL-18A CCCP-75647 (c/n 188000401). Reregistered CCCP-27220 and designated



Andrey Yurgenson

A three-view of the IL-20M, with an additional side view (bottom) of the IL-20RT.

Ilyushin Aviation Complex

Above: The IL-18SIP airborne measurement station (CCCP-27220, c/n 188000401), the prototype of the IL-20RT, as originally flown in pre-1973 colours. Note the low-set Soviet flag on the tail.

Ilyushin Aviation Complex

Above: CCCP-27220 at a later date following repaint in 1973-standard Aeroflot colours. The door and window arrangement typical of the late-production IL-18B is readily apparent.

Ilyushin Aviation Complex

Above: CCCP-75480, the first production IL-20RT (c/n 173011405), following installation of the rear radome which was missing originally. The colour scheme and door/window arrangement are quite different from the IL-18SIP.

Yefim Gordon

IL-20RT CCCP-75481 (c/n 173011503) at Ostrov AB in mid-1996, showing to advantage the rear thimble radome. Note the Sukhoi Su-33 shipboard fighters and the Beriyev A-40 Albatross amphibian in the background using the base for participation in a military parade in St. Petersburg to mark the Russian Navy's 300th anniversary.

Yefim Gordon archive

CCCP-75903 No.1 (c/n 0393610235) represents the first production version of the IL-22 airborne command post (also designated IL-18D-36 'Bizon'). Based at Kubinka AB, this aircraft retained the CCCP- prefix and Soviet flag until 1998.

IL-18SIP (*samo**lyot**nyy izme**ri**tel'nyy poonkt* – airborne measuring station) or IL-18RTL (*retrans**lya**tor-labora**to**riya*), this aircraft was instantly recognizable by the huge slab-sided dorsal canoe fairing with three access hatches on each side. A flattened teardrop fairing incorporating a square dielectric panel was mounted on each side of the fin about half-way up, and a fairly large thimble radome with a blade aerial above the root supplanted the standard tailcone. Several forward-pointing probe aerials were located above the flightdeck windscreen.

The production aircraft were based on new-build IL-20 airframes. Apart from the different door and window arrangement *à la* IL-20M, the IL-20RT differed from the experimental IL-18SIP in lacking the fin fairings and the flightdeck roof probes. The nose gear doors were bulged (this was the current production standard) but no mudguard was fitted because there was no longer a ventral radome to be protected from flying stones.

The IL-20RT's mission avionics included the RTS-9 (***rah**diotelemet**rich**eskaya **stahn**tsiya* – radio telemetry station) and BRS-4 telemetry receivers, the SYeV-12 time synchronisation system (*sis**tem**a yedi**nov**o **vre**meni*) and additional voice link and telegraph communications equipment; their antennas were housed in the dorsal and tail fairings. The avionics suite was worked by ten operators.

Four production IL-20RT aircraft – CCCP-75480 through CCCP-75483 (c/ns 173011405, 173011503, 173011505 and 173011601) – were built in 1973. They wore a non-standard Aeroflot colour scheme: the cheatline ran below the windows rather than across them, the registration was applied in black on white rather then white on blue, and the Aeroflot logos were very small. (In comparison, the IL-18SIP wore full 1973-standard Aeroflot livery in the closing stages of its career.)

The production aircraft were based at Yoobileynyy airfield in Leninsk (currently Tyuratam), Kazakhstan, which served the Baikonur space centre and were used during trials of rockets and satellites. Later, when five new 'aircraft 976' radar picket/telemetry and communications relay aircraft also known as IL-76SK became available, the IL-20RT space trackers were stripped of all mission equipment and used as transports and trainers; one of the four aircraft, CCCP-75481, ended up in the AVMF Combat & Conversion Training Centre at Ostrov AB. The aircraft still had its trademark 'hump' and tail fairing – and, oddly enough, retained the old Soviet prefix and flag.

The IL-18SIP, on the other hand, was retained by LII and used during tests of air-launched cruise missiles. It was retired before 1992, and was finally scrapped by August 1993.

IL-18 – main specifications

	IL-18A	IL-18B	IL-18V	IL-18E	IL-18D
Length overall	35.7 m (117 ft 1 in)	35.9 m (117 ft 9 in)	35.9 m (117 ft 9 in)	35.9 m (117 ft 9 in)	35.9 m (117 ft 9 in)
Wing span	37.4 m (122 ft 8 in)	37.4 m (122 ft 8 in)	37.4 m (122 ft 8 in)	37.4 m (122 ft 8 in)	37.4 m (122 ft 8 in)
Landing gear wheelbase	12.755 m (41 ft 10 in)	12.755 m (41 ft 10 in)	12.755 m (41 ft 10 in)	12.755 m (41 ft 10 in)	12.755 m (41 ft 10 in)
Landing gear track	9.0 m (29 ft 6 in)	9.0 m (29 ft 6 in)	9.0 m (29 ft 6 in)	9.0 m (29 ft 6 in)	9.0 m (29 ft 6 in)
Height on ground	10.165 m (33 ft 4 in)	10.165 m (33 ft 4 in)	10.165 m (33 ft 4 in)	10.165 m (33 ft 4 in)	10.165 m (33 ft 4 in)
Wing area, m² (sq ft)	140.0 (1,505.3)	140.0 (1,505.3)	140.0 (1,505.3)	140.0 (1,505.3)	140.0 (1,505.3)
Overall pressure cabin volume, m³ (cu ft)	237.5 (8,387)	237.5 (8,387)	237.5 (8,387)	237.5 (8,387)	237.5 (8,387)
Empty operating weight, kg (lb)	29,450-30,579 (64,925-67,414)	n.a.	31,500 */34,500 § (69,440) */(76,060) §	34,630 (76,340)	34,000/35,000 § (74,955)/(77,160) §
Maximum take-off weight, kg (lb)	58,000-59,350 (127,865-130,840)	61,200 (134,920)	61,200 (134,920)	61,200 (134,920)	64,000 (141,090)
Maximum landing weight, kg (lb)	n.a.	51,200 (112,870)	51,200 (112,870)	51,200 (112,870)	n.a.
Maximum payload, kg (lb)	12,000 (26,455)	14,000 (30,865)	13,500 (29,760) †	13,500 (29,760)	13,500 (29,760)
Payload in maximum-range flight, kg (lb)	n.a.	n.a.	9,400 (20,720) †	n.a.	6,500 (14,330)
Economic cruising speed, km/h (mph) (at 8,000 m/26,250 ft)	n.a.	n.a.	600 (372)	625 (388)	625 (388)
Top speed, km/h (mph)	n.a.	n.a.	650 (403)	675 (419)	675 (419)
Service ceiling, m (ft)	n.a.	n.a.	12,500 (41,010)	12,500 (41,010)	11,800 (38,710)
Maximum range, km (miles)	5,400 (3,350)	5,400 (3,350)	5,400 (3,350)	5,400 (3,350)	6,500/7,100 (4,040/4,410) §
Range with max payload, km (miles)	3,300 (2,050)	3,300 (2,050)	3,000/3,300 (1,860/2,050) §	3,200/3,300 (1,990/2,050) §	3,700/4,300 (2,300/2,670) §
Take-off run, m (ft)	n.a.	n.a.	1,100 (3,610)	1,100 (3,610)	1,350 (4,430) ‡
Landing run, m (ft)	n.a.	n.a.	n.a.	n.a.	850 (2,790)

* With APU but with the seats removed.
† APU-equipped aircraft only; for aircraft lacking an APU the maximum payload was 14,000 kg (30,860 lb) and the payload in maximum range configuration was 9,900 km (21,825 lb). The maximum payload could be carried on routes not exceeding 2,750 km (1,700 miles).
‡ At maximum TOW.
§ Different sources give different figures.

IL-22 *Coot-B* airborne command post (IL-18D-36 'Bizon', *izdeliye* 36)

This, one of the most enigmatic versions of the IL-18D, was developed by the Myasishchev Experimental Machinery Plant (EMZ), not by Ilyushin. The reason was that OKB-240 was not in a position to handle the project, having its hands full refining the IL-38 and the then-new IL-62 airliner and designing the IL-76 transport.

The choice of the IL-18 as the basis for a new airborne command post was dictated by several reasons. High endurance and long range (4,000-5,000 km/2,485-3,100 miles), high reliability and the ability to operate from relatively short runways away from the home base for extended periods were prime requirements; high speed, on the other hand, was not. This narrowed the choice of platform to turboprop aircraft with proven airframes and powerplants (the IL-62 still had to make its mark and required long runways).

The An-12 transport was unsuitable because of its unpressurised freight hold. Since aircraft factory No.39 in Irkutsk and factory No.64 in Voronezh had stopped building the type, a fully pressurised version of the An-12 could only be manufactured at the Tashkent aircraft factory No.84 which had more important tasks, gearing up to build the An-22 strategic ailifter. The pressurised An-10 airliner from which the An-12 was derived had inadequate range and suffered from design faults which eventually caused it to be retired from Aeroflot service in May 1972. The IL-18, on the other hand, was a widespread and reliable aircraft operated by Aeroflot and the Soviet Air Force alike and outperformed all competing turboprop designs.

Development of a new ABCP derivative of the *Coot* was initiated by Communist Party Central Committee/Council of Ministers joint directive No.603-215 of 7th August 1968 and by MAP order No.312 of 6th September. EMZ was assigned responsibility for this programme and the aircraft was allocated the service designation IL-22.

Originally the IL-22 programme was known in-house as Project 36 and bore the codename ***Bi**zon* (Bison); hence the initial version of the IL-22 received the manufacturer's designation IL-18D-36 '***Bi**zon*' or *izdeliye* 36. Ivan I. Razhev was appointed chief project engineer; Fyodor N. Zhookov was also actively involved in the IL-22 programme, along with I. P. Vorob'yov, V. S. Boyko, V. P. Goosev, V. N. Yepishkin, A. A. Koorazhkin and S. V. Belobrov.

The IL-22 (aka IL-18D-36 'Bizon'), or *izdeliye* 36, was immediately recognizable by the characteristic cigar-shaped antenna fairing atop the fin which required relocation of the upper anti-collision beacon to the centre fuselage. Another trademark feature was the shallow ventral fairing of semi-circular cross section running almost the full length of the fuselage; this was dielectric and housed more antennas. It was flanked by two small strake-like fairings of unknown purpose starting about level with the wing leading edge.

Two small blade aerials were mounted dorsally above the three forward cabin windows, followed by a slightly larger blade aerial just aft of the forward entry door and then a huge blade aerial in line with the overwing emergency exits. Another small blade aerial was located low on the starboard side of the nose beside the ventral canoe fairing and three more (one plus two abreast) aft of the said fairing.

The fuselage incorporated some structural changes. The window arrangement differed from the IL-18D (3+door+2+two emergency exits+1+5+door+2 to port and

Mikhail Yevdokimov

IL-22M (IL-22M-11 'Zebra') RA-75913 (c/n 0394011098) at Chkalovskaya AB on 15th August 1999. This base boasts the largest concentration of *Coot-Bs* anywhere.

Mikhail Yevdokimov

Above: The latest version of the IL-22, whose exact designation remains unknown, features characteristic 'hockey stick' aerials above and below the centre fuselage. IL-22M RA-75909 (c/n 0394011092), seen here at Chkalovskaya AB on 15th August 1999, was the first to be converted.

Sergey Popsuyevich

A few *Coot-Bs* found themselves outside Russia after the demise of the Soviet Union. IL-22M-11 75918 was one of two Ukrainian Air Force examples; it was operated by the 243rd OSAP from Sknilov AB near L'vov.

3+2+two exits+1+4+2+2 to starboard). An escape chute and hatch were installed on the starboard side, supplanting the rear baggage door *à la* IL-20M. However, this was not enough, since there would be a high-ranking officer and his staff on board in addition to the crew and the single chute could become a bottleneck. Hence a large slip-stream deflector powered by two faired hydraulic rams was mounted ahead of the rear entry door, making it possible to bail out that way. The nose gear unit featured a mud-guard to protect the ventral canoe fairing (and suitably bulged gear doors), but many IL-22s had it removed in service.

The aircraft featured a 'war room' and was fitted with various communications equipment (including Satcom), as well as scrambling/descrambling, data storage and electronic support measures equipment. The mission equipment (mostly located in the former baggage compartments) used a lot of power and the engine-driven generators could no longer cope with the load, so the TG-16 APU was replaced by a more powerful TA-6 unit (the same one as on the IL-76, IL-62 and Tu-154). The APU featured two small intakes located above one another on the port side near the fin fillet and closed by square doors with external stiffening ribs; the exhaust was located under the port stabiliser (rather than on the starboard side ahead of the horizontal tail) and surrounded by a large heat-resistant steel plate. The new APU gave a bonus, allowing the equipment to be operated and the cabin to be air-conditioned on the ground.

Two standard IL-18s (identities unknown) were converted to IL-22 prototypes by Myasishchev's experimental shop at Zhukovskiy in 1970, entering State acceptance trials in the same year. The trials went successfully and the aircraft entered limited production at MMZ No.30. The IL-22s were built 'green' and flown to Zhukovskiy where they were fitted out with mission equipment at the Myasishchev facility. Interestingly, the IL-22 had a separate c/n system to confuse would-be spies. Thus, CCCP-75903 is c/n 0393610235; 039 is a code for the Moscow Aircraft Production Association named after Pyotr V. Dement'yev (MAPO), 36 is a product code and the remaining five figures are a computer-generated number which does not mean *anything at all* so as not to reveal the batch number and the number of the aircraft in the batch.

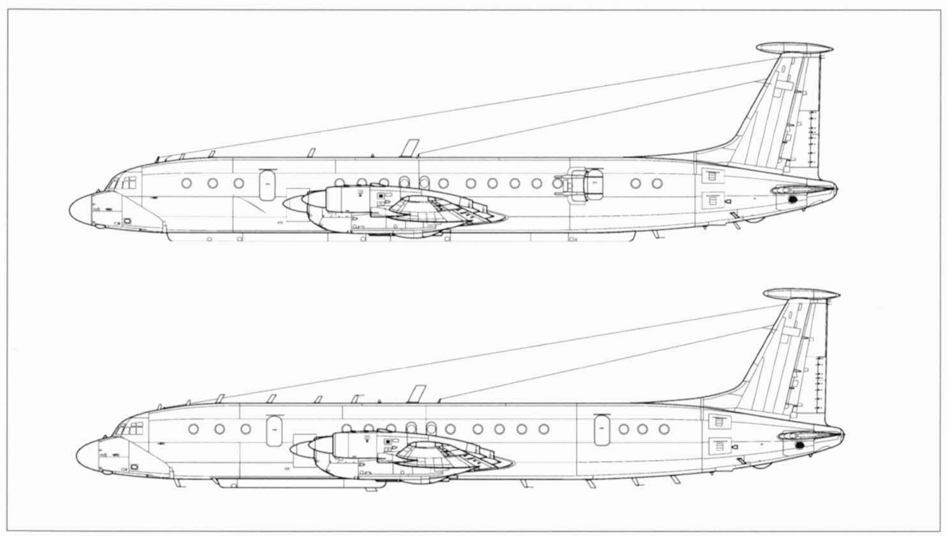
Despite their military role, all IL-22s were quasi-civil and wore full 1973-standard Aeroflot colours (and 'IL-18' nose titles!). A large batch of registrations was set aside for the IL-22s, though they did not always run in sequence. Known IL-18D-36s were registered CCCP-75895 through CCCP-75907.

On 14th May 1994 the IL-22 had its public debut when CCCP-75903 was displayed during an open doors day at Kubinka AB west of Moscow. Later the general public was able to see the IL-22 at close range during further events at Kubinka and the Aviation Day displays at Chkalovskaya AB.

Actually the IL-22 had been discovered by the West some time earlier, receiving the NATO reporting name *Coot-B*.

IL-22M *Coot-B* airborne command post (IL-22M-11 'Zebra', *izdeliye* 40)

A second version of the *Coot-B* appeared later, receiving the manufacturer's designation *izdeliye* 40 and the service designation IL-22M-11 'Zebra' or simply IL-22M. There are indications that it was developed in 1977 under Project 11-U concerning ABCPs with all-new mission equipment, hence the -11 suffix to the designation (the U probably stood for *oopravleniye* – control, referring to command, control and communications centres).



Andrey Yurgenson

Top: The IL-22 (IL-18D-36 'Bizon').
Above: The IL-22M (IL-22M-11 'Zebra').

Outwardly the IL-22M-11 differed from the IL-18D-36 primarily in having a much shorter ventral fairing which began just aft of the first cabin window (rather than immediately aft of the nose gear) and terminated at the wing leading edge. The dorsal antenna farm now comprised two small blade aerials, two slightly larger ones in line with the second cabin window and the forward entry door, one small blade aerial, one L-shaped aerial and the familiar huge blade aerial. The ventral fairing was flanked by one small blade aerial to port (at the front) and two medium blade aerials plus one huge one to starboard (at the rear), while the existing blade aerials aft of the wings were complemented by one L-shaped aerial and two small blade aerials on the centreline.

The window arrangement again differed from the standard airliner (3+door+3+two emergency exits+1+4+door+3 to port and 3+two exits+1+4+1+3 to starboard). The slipstream deflector near the aft entry door was deleted, as the chances of bailing out successfully through the door were considered too small.

Known IL-22M-11s were registered CCCP-75908 through CCCP-75929 and again some registrations were out of sequence. Thus the total number of *Coot-Bs* in existence was around 35. Again, most examples were new build aircraft with 'counter-espionage' c/ns featuring the 'famous last five'. At some point the factory code was changed from 039 to 296 as an additional security measure; cf. CCCP-75912 (c/n 0394011097) and CCCP-75925 (c/n 2964017557).

At least six 'Zebras', however, were converted from standard IL-18Ds, and these are *not* prototypes. The IL-18 production line at MMZ No.30 ultimately had to be closed after 1983 and the jigs thrown away because the factory had to fill a growing demand for the MiG-23 *Flogger* tactical fighter while preparing to build its successor, the MiG-29 *Fulcrum*. However, the Air Force's demand for IL-22s proved unexpectedly high. Since no new-build airframes could be obtained any more, several low-time IL-18Ds were 'requisitioned' from Aeroflot and transferred to the VVS for conversion to IL-22M-11s. After conversion such aircraft were issued new registrations in the CCCP-759xx block to fit the general pattern. Most retained their original c/ns but in some cases the first four digits were replaced with 29640, resulting in a strange hybrid c/n. Thus, IL-18D CCCP-74270 (c/n 188011203) briefly became c/n 2964011203 after conversion to IL-22M CCCP-75926 but then reverted to its original c/n.

IL-22s operated from Chkalovskaya AB (8th ADON), Kubinka AB and Ostaf'yevo AB near Moscow, Dyaghilevo AB near Ryazan', Irkutsk and other bases. For instance, IL-18D-36 CCCP-75896 was based at Vinnitsa in the Ukraine. IL-22M-11 CCCP-75916 was operated by the 50th OSAP at Machulishchi AB near Minsk. A sister aircraft (CCCP-75918) belonged to the 243rd OSAP stationed at Sknilov AB near L'vov; a third IL-22M-11 (CCCP-75929) was operated by a unit stationed near Kishinyov and a fourth (CCCP-75915) somewhere in Kazakhstan. They were taken over by the Belorussian, Ukrainian, Moldovan and Kazakh air forces respectively after the collapse of the USSR.

IL-22s have been seconded to the Group of Soviet Forces in Germany (Sperenberg AB) and the Northern Group of Forces (Poland, Legnica AB). The type has also been reported as based at Pushkin near St. Petersburg but this is misconception, as the aircraft were simply on overhaul at the local aircraft repair plant No.20.

IL-22/IL-22M mid-life updates

During their service career some aircraft have received new equipment fits, as evidenced by new antenna arrangements. For example, IL-18D-36 CCCP-75906 has had the ventral fairing removed altogether. IL-22M-11s RA-75920 and RA-75924 have much-reduced dorsal antenna farms comprising two small blade aerials, one slightly bigger one and one L-shaped aerial.

The most impressive upgrade, however, was introduced by IL-22M RA-75909 (c/n 0394011092) in the spring of 1998. The top of the fuselage ahead of the wings bristles with two small and four large unswept blade aerials, and two huge 'hockey stick' aerials with thin forward-pointing probes are mounted ahead and aft of the emergency exits. The ventral fairing is replaced by two strake aerials of roughly the same length; there are also two small unswept blade aerials low on the port side of the nose and a small swept blade aerial, a large unswept blade aerial and a 'hockey stick' aerial (identical to the dorsal ones) low on the starboard side. At least two more *Coot-Bs*, IL-22 75902 (c/n 0393610226) and IL-22M RA-75908 (c/n 0394011091), were similarly upgraded later; quite possibly this sub-variant has an as-yet undisclosed separate designation.

Five IL-22s were stripped of mission equipment and used as airliners (and mostly appear as IL-18Ds in fleet lists!). In so doing most of the aerials associated with the HF comms suite were removed, but the characteristic fin tip pod and APU placement remained. Thus, Ukrainian Air Force IL-18D-36 CCCP-75896 was sold to the Angolan airline ALADA as D2-FFR. IL-18D-36 RA-75903 became a VIP transport with the Russian Air Force's 16th Air Army; it was displayed as such at Kubinka AB on 8th August 2002 on occasion of the 16th VA's golden jubilee.

IL-22M-11 ER-75929 was sold to Vichi Airlines (the commercial division of the Moldovan Air Force), flying alternately in all-cargo or 105-seat all-economy configuration, and was occasionally leased to the Romanian airline Acvila Air. Another example, YL-LAO (ex-Belorussian Air Force CCCP-75916), was operated by the Riga-based Concors Airlines since June 1998. The aircraft has a mixed-class arrangement, including a luxurious VIP cabin at the rear. Both aircraft have had most of the IL-22's aerials removed, retaining only the fin tip 'cigar'; yet this, along with the non-standard APU location and the absence of windows on the starboard side of the nose, indicates their origin all too clearly! A third IL-22M-11, UN-75915, became a VIP aircraft. Unfortunately it was written off in a ground collision with a runaway An-12 in January 1995 only a few days after the extensive and expensive conversion had been completed.

IL-38 *May* maritime patrol/ASW aircraft (*izdeliye* 8)

In the late 1950s new classes of offensive weapons started taking shape in the USA and the Soviet Union; these later formed the so-called nuclear triad comprising ground-launched intercontinental ballistic missiles (ICBMs), strategic bombers and nuclear-powered missile submarines (SSBNs). The Americans were quick to realise the advantages conferred by arming a submarine with ICBMs. Submarines could travel quickly and stealthily to the required areas of the world ocean to launch missile strikes against the Soviet Union and possibly its Warsaw Pact allies. While the first sea-launched ballistic missiles (SLBMs) required the sub to surface, more advanced models capable of underwater launch were soon developed, adding to the submarine's stealth and minimising the danger of being destroyed.

This, in turn, sparked the development of appropriate defensive weapons. For example, the advent of submarines armed with SLBMs led to new developments in anti-submarine warfare (ASW) systems. Maritime patrol and ASW aircraft became one of the primary means of countering the submarine threat both in the USA and the USSR.

The USA quickly started the Polaris programme which was to bolster the US Navy with 41 SSBNs, as well as appropriate land support systems and, at a later stage, satellites. The first five submarines were armed with 16 Polaris A-1s with a 2,200-km (1,189-nm) range; later subs carried Polaris A-2 missiles with a 2,800-km (1,513-nm) range and, later still, Polaris A-3s with a 4,600-km (2,486-nm) range.

As for countermeasures, the USA spent a lot of effort and money on setting up a stationary Sound Surveillance System (SOSUS) which became operational on the East Coast in 1954 and on the West Coast in 1958. Some sources claimed SOSUS had a detection range of 1,000-1,200 km (540-648 nm). Fielding a similar system in the USSR was impossible due to geographical factors, the Soviet industry's lag in hydrophone systems development and the prohibitive costs involved. Thus, aircraft became the only viable option, and the 100 or so obsolete Beriyev Be-6 *Madge* piston-engined flying boats posed no serious threat.

In 1958-60 the Soviet defence research establishments undertook the *Vyaz* (Elm) and *Mozhzhe**vel'**nik* (Juniper) research and development programmes. These resulted in the formulation of general operational requirements (GORs) for ASW aircraft and helicopters, as well as for the submarine detection equipment and weapons they were to carry, to be ordered from the defence industry in the near future.

No fewer than six ASW systems were proposed to the Soviet Navy under the Vyaz programme, including four fixed-wing aircraft and two helicopters. The Navy amended the projected performance of the Kamov Ka-25 *Hormone* shipboard ASW helicopter, defined ways of improving airborne submarine detection systems – and issued a GOR for a long-range shore-based ASW aircraft based on the IL-18V which is the subject of this story. The aircraft was to have a 2,200-km (1,189-nm) combat radius and an on-station loiter time of 3-3.5 hours; this should enable it to counter submarines armed with Polaris A-1 SLBMs. The principal armament consisted of AT-1 ASW torpedoes (*aviatsi**on**naya torpe**da*** – aircraft torpedo) which were being tested at the time; conventional and nuclear depth charges were also under consideration.

The Mozhzhevel'nik R&D programme, which began almost simultaneously, was of a more specific nature. It culminated in the development of a specific operational requirement (SOR) for the aircraft's sonobuoy system, as well as SORs for the VGS-2 ***Oka*** (the name of a river in Russia) dunking sonar (developed for the Ka-25) and for the ***Ga**gara* (Loon) infra-red search and track system.

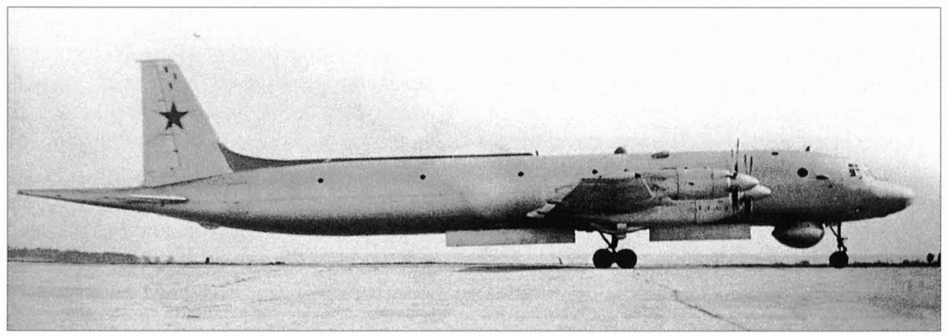
Defence industry proposals set forth in the course of the Vyaz and Mozhzhevel'nik programmes were studied and altered. For example, the military turned down the offer to develop an airborne early warning system which would detect and track ballistic missiles launched by enemy submarines and allow the latter to be pinpointed and destroyed straight away. The same fate befell a proposed long-range ASW system built around a multi-role amphibian.

Ilyushin Aviation Complex

Above: The prototype IL-38 was built by cutting up an IL-18 airframe. It is seen here during State acceptance trials. Interestingly, the ventral radome was of all-metal construction on the prototype, as this aircraft was purely an aerodynamics test vehicle.

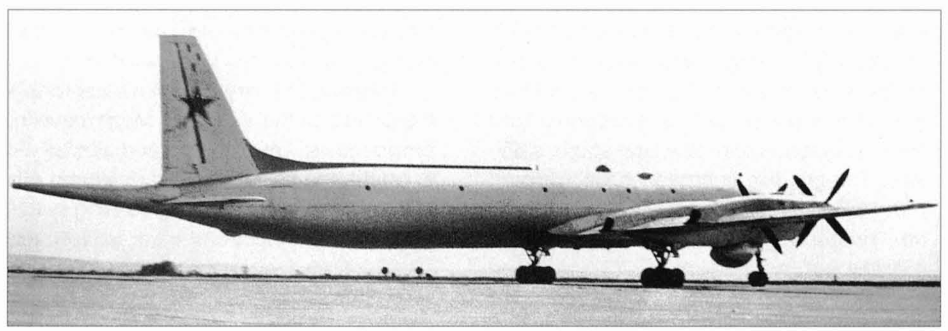
The Soviet Navy compared the capabilities of shore-based and amphibian aircraft in the long-range maritime patrol and ASW role. The verdict was that development of an amphibian in this class involved major technical difficulties; the aircraft would be overweight and less aerodynamically efficient than a landplane without giving any tactical advantage. Eventually after carefully analysing all options the Navy selected an ASW derivative of the IL-18 airliner. Interestingly, the US and British military had taken the same approach; Lockheed had derived the P-3 Orion from the L-188 Electra, while the Hawker Siddeley HS 801 Nimrod (now British Aerospace Nimrod) was an evolution of the de Havilland DH.106 Comet 4.

Thus at this stage the Soviet ASW development programme included four basic components – a long-range shore-based ASW system based on the IL-18, a short-range system built around the Beriyev Be-12 Chaika (Seagull/*Mail*) amphibian, a shore-based amphibious helicopter (the future Mil' Mi-14PL *Haze-A*) and the shipboard Ka-25PL *Hormone-A*.



Ilyushin Aviation Complex

Above: The IL-38 prototype with both weapons bays open.



Ilyushin Aviation Complex

Another view of the prototype, showing the MAD boom and the glassfibre fin fillet/spine. The aircraft is unpainted and uncoded. Note the dorsal blister fairing (probably associated with test equipment) which was not fitted to production aircraft.

The choice of the *Coot* as the starting point was a good one. Firstly, the IL-18's capacious fuselage offered ample space for the search and targeting system, weapons, crew and the additional fuel required to give the aircraft the specified maximum endurance of 16 hours. Secondly, the airliner's proven airframe, powerplant and systems ensured adequate reliability during long overwater missions in constantly changing weather conditions. Thirdly, the IL-18 had fairly high performance and good manoeuvrability, which meant an ASW aircraft based on it could quickly reach ocean areas located thousands of kilometres from its base and patrol the area at 100-2,000 m (330-6,560 ft), making tight turns. The aircraft would be capable of autonomous operation from bases with relatively short strips and minimum ground support facilities which were common in the Soviet Navy's North and Pacific Fleets. Finally, development time and costs were greatly reduced as compared to an all-new aircraft; the time issue was especially important, since the US Navy's first nuclear-powered missile submarine, the USS *George Washington* carrying sixteen Polaris A-1 SLBMs, had been commissioned in late 1959.

The long-range ASW derivative of the IL-18 was designated IL-38 and included into the Naval Air Arm's re-equipment programme. Later, as the range of SLBMs increased, the long-range ASW role was reassigned to the Tupolev Tu-142, which had flight refuelling capability, and the IL-38 was regarded as a medium-range system.

Officially development of the IL-38 at OKB-240 was initiated by Communist Party Central Committee/Council of Ministers joint directive No.640-261 issued on 18th June

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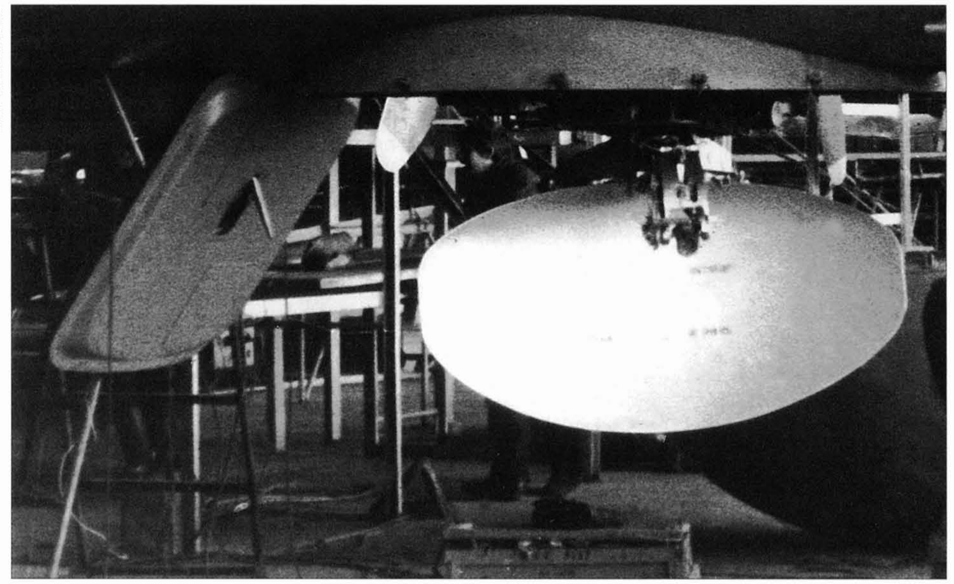
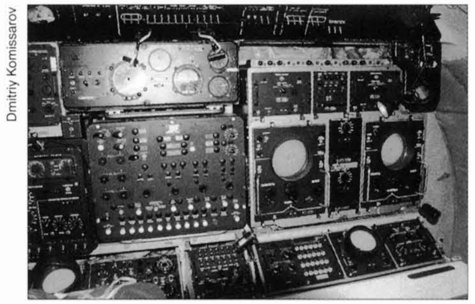
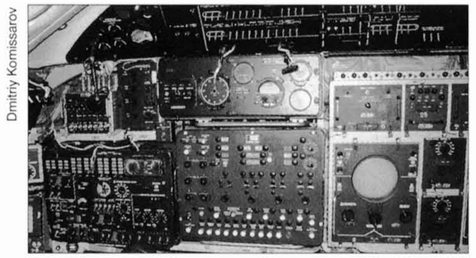


The antenna of the Berkoot radar with the radome removed. The stencil on the radar reads *Nastroyeno – ne trogat'* (Tuned – Do not touch).

Dmitriy Komissarov



Dmitriy Komissarov



The aft-facing workstations of the search radar operator (top) and the operator of the aircraft receiver/indicator (above) on the IL-38, showing the four circular cathode-ray tube displays.

1960. The document said the first prototype was to commence trials in the second quarter of 1962 (minus operational equipment), followed by the fully-equipped second aircraft in the fourth quarter of the same year.

General Designer Sergey V. Ilyushin supervised IL-38 development, with his deputy Yakov A. Kootepov as chief project engineer. V. M. Ghermanov and Radiy P. Papkovskiy were also actively involved in the design effort. Advanced project development and issue of manufacturing drawings proceeded in close cooperation with Soviet Navy representatives. The Navy kept making amendments to the SOR which, as a result, was not finalised until April 1961 when prototype construction had already begun.

At the ADP stage the Ilyushin OKB had to work out the ideology and operational tactics of the ASW system together with the Soviet Navy and other organisations involved in the IL-38 programme; these included more than a dozen design bureaux and research institutes. The project was completed in just a few months thanks in no small part to the dedication and industriousness of ADP section employees L. M. Ryabov, Yuriy I. Yoodin, V. M. Sheynin, N. P. Stolbovoy, Radiy P. Papkovskiy, G. G. Murav'yov and O. N. Yelsookova.

The contours of the IL-38's main airframe subassemblies (fuselage, wings, tail unit and engine nacelles) were identical to those of the IL-18. There was also considerable structural and systems commonality; the flightdeck section, the tail unit and all control surfaces, the powerplant (four 4,250-ehp/3,169-ekW Ivchenko AI-20M turboprops driving AV-68M four-bladed reversible-pitch propellers of 4.5 m (14 ft 9⅛ in) diameter and a TG-16 auxiliary power unit), the engine control and fire suppression systems, the de-icing system, the landing gear, many electric and hydraulic components and the like were borrowed straight from the airliner.

The wing torsion box was identical to that of the experimental IL-18I, featuring an integral fuel tank in the centre section. The same design was later used on the ultimate production version of the *Coot*, the IL-18D evolved from the IL-18I. The fuel system comprised 25 tanks holding a total of 33,820 litres (7,440.4 Imp gal) – integral tanks in the outer wings and wing centre section and flexible bag tanks in the fuselage – and featured three-point pressure refuelling; gravity refuelling was also possible through eight filler caps. A fuel management system controlled the tank emptying sequence, automatically maintaining CG position within the prescribed limits.

From the outset the IL-38 was developed as part of an ASW complex featuring the Berkoot (Golden eagle) search and targeting system (STS); the latter was built around a 360° search radar of the same name with a large ventral radome located aft of the nose gear unit. The need to accommodate the system's built-in and droppable components, as well as weapons, led to major structural changes. First of all, the combined weight of the mission avionics and weapons caused a significant forward shift in the aircraft's CG; to compensate for this the wings had to be moved 3 m (9 ft 10⅛ in) forwards. This changed the aircraft's proportions completely, giving the IL-38 an uncannily dachshund-like appearance.

The air conditioning system was modified to suit the greatly reduced pressure cabin volume and because of the need to heat the weapons bays and heat/cool certain modules of the Berkoot radar set. Hence two heat exchangers in fairly large elongated fairings were mounted high on the fuselage sides just ahead of the wings. Installation of the mission equipment also led to changes in the electric system.

Two weapons bays closed by twin doors were located ahead and aft of the wing centre section; the aft bay was for weapons proper, while the forward bay held sonobuoys. Because of the aircraft's military role the IL-18's port side entry doors and most of the cabin windows were deleted. The crew entered via a forward-opening ventral hatch immediately aft of the radome opening into a sloping passage; this doubled as an escape chute, the access hatch cover acting as a slipstream deflector. The remaining windows (except the one nearest to the flightdeck on each side) were reduced in size.

Apparently the Berkoot search radar had a secondary weather reconnaissance function, since the IL-18's RPSN-2 Emblema weather radar was deleted and the nose radome replaced by a fairing of identical shape, only the forward half of which was dielectric. Finally, the fuselage terminated in a long tapered boom housing the sensor of the magnetic anomaly detector (MAD).

Internally the fuselage was divided into two sections. The forward section was the pressure cabin, also divided into two parts – the flightdeck (accommodating the captain, first officer, flight engineer, navigator and radio operator) and the rear section where the crew entry hatch was. In the rear cabin, facing aft, sat the search radar operator and the operator of the aircraft receiver/indicator (ARI), a device processing and displaying incoming signals generated by the sonobuoys. There was a well-founded opin-


Sergey and Dmitriy Komissarov archive

A trio of IL-38s makes a flypast at Moscow-Domodedovo airport during the 9th July 1967 air fest.

ion that having the operators face aft would increase crew fatigue, but the limited space of the pressure cabin did not allow their workstations to be redesigned to face forward. Since the sorties would be quite long, the rear cabin featured a galley, a table, a toilet and a rest area with a folding bunk.

The unpressurised rear and lower portion of the fuselage incorporated the two above-mentioned weapons bays with a total volume of 30 m³ (1,059.4 cu ft). A container for two fuel cells holding a total of 4,200 litres (924 Imp gal) was installed above the forward weapons bay. An avionics bay housing the Berkoot modules, including the digital computer, was located further aft near the CG. The APU was installed aft of the rear weapons bay; its exhaust was located to port about halfway between the wings and tail instead of just ahead of the starboard stabiliser, as on the IL-18. The rear fuselage was accessible in flight from the pressure cabin after the pressure differential between the two had been eliminated; two walkways ran the full length of the rear fuselage.

The avionics suite consisted of three main groups: navigation, communications and targeting equipment. The former group comprised a DISS-1 Doppler speed and drift sensor, an RSBN-2S Svod (Dome) short-range radio navigation (SHORAN) system, an SP-50 ILS, an ARK-11 ADF and an RV-4 radio altimeter. Communications equipment included an SPU-7B intercom, an SGU-15 loudspeaker system, an R-802V command link radio, an R-632 decimetre-waveband command link radio, R-836 Neon and R-847A VHF communications radios, a *Pe**leng*** (Bearing) HF communications radio and an MS-61 cockpit voice recorder. Finally, the targeting equipment consisted of the Berkoot STS which will be described in more detail later.

The oxygen system enabled the crew to work normally in the event of a decompression, to enter the unpressurised rear fuselage in flight and to bail out safely 'if all else failed'. The system comprised 19 stationary 36-litre (7.92 Imp gal) bottles with gaseous oxygen and one 7.6-litre (1.672 Imp gal) portable bottle. When bailing out the crew used KP-23 breathing apparatus with enough oxygen for 11 minutes.

Ilyushin engineers had given a lot of thought to crew rescue in the event of a ditching. The IL-38 was tested for ditchability in model form on the Moscow Sea (a large reservoir north of Moscow); impact details and the aircraft's buoyancy were studied and design features ensuring safe evacuation developed accordingly. After ditching the crew was to vacate the aircraft either via a dorsal escape hatch in the middle of the pressure cabin or via an overwing emergency exit on the port side of the unpressurised centre fuselage. A bay with a PSN-6A six-man life raft (*plot spa**sah**tel'nyy nadoov**noy***) was located just aft of the port wing. The bay cover could be opened both from outside and from within by means of cables; the raft then popped out near the wing trailing edge, inflated and was secured by a line to stop it from drifting away. The PSN-6A had a tent to shelter the crew from the elements and carried a three days' supply of food and water for the entire crew, a transceiver, a supply of signal flares, a first-aid kit and a repair kit.

Individual rescue equipment included S-5 parachutes, MLAS-1-OB one-man inflatable rafts and MSK-3M maritime rescue suits (*mor**skoy** spa**sah**tel'nyy kos**tyum***). The parachute pack contained, apart from the parachute itself, an NAZ-7 survival kit (*no**sim**yy ava**reey**nyy za**pahs***) – a three days' food ration, an emergency radio, signal flares and a few other 'bare necessities'.

Another peculiarity of overwater operations was the corrosive salty environment. Hence the IL-38 featured enhanced corrosion protection of the airframe, engines and systems.

The weapons range comprised AT-1 and AT-2 ASW torpedoes, PLAB-250-120 Lastochka (Swallow), PLAB-50 and KAB-500PL *Za**gon*** (Corral) depth charges, mines and a variety of free-fall bombs used against surface ships. Nuclear depth charges could also be carried. About 30 payload combinations were possible and the maximum payload, including RGB-1, RGB-2 and RGB-3 sonobuoys, was 8,000 kg (17,640 lb).

Development of the Berkoot STS at NII-131 (LNPO Leninets) in Leningrad began in December 1959 pursuant to Council of Ministers directive No.1335-594 issued on 11th December. Initially the design effort was led by V. S. Shoomeyko who died in harness and was succeeded by A. M. Gromov and P. A. Iovlev. More than ten other research establishments and design bureaux were involved in the IL-38 programme; for example, the sonobuoys were developed by NII-753 in Kiev, while the weapons system's ideology was worked out by the Naval Academy and other institutes.

The STS was designed to detect enemy submarines and provide target data for their destruction. It enabled the IL-38 to go automatically to the required area of the ocean, set up straight and curved barriers made up of sonobuoys in the submarine's anticipated path and then monitor the incoming signals.

Three models were used: RGB-1 non-directional passive buoys, RGB-2 passive buoys and RGB-3 active/passive buoys. Signals generated by the sonobuoys were picked up by the search radar and processed by the aircraft receiver/indicator. The latter, besides visualising sonobuoy operation on a display, allowed the operator to listen to noises transmitted by the RGB-1 buoys, determine target bearing relative to the RGB-2 buoys and target bearing/range relative to the RGB-3 buoys. The ARI could perform a brief scan of the dropped sonobuoys in 1 second or a detailed scan in 60 seconds.

Surfaced submarines and subs travelling at periscope or snorkel depth could be detected directly by the radar – an inherently archaic approach. Besides the 360° search mode, the radar had 120° and 150° sector viewing modes and handled some navigation tasks as well (it had a ground mapping mode). Finally, the submarines could be detected by the APM-60 Orsha MAD (*aviat**sion**nyy protivo**lod**ochnyy magni**tom**etr* – aircraft-mounted anti-submarine magnetometer) which operated independently from the Berkoot system.

The STS also received inputs from numerous air data sensors, the Put'-4B-2K (Way) compass system, the AP-6Ye autopilot, the ARK-B ADF and the like. All this equipment was linked into a single suite by the TsVM-264 digital computer (*tsifro**va**ya vychis**lit**el'naya ma**shin**a*) developed under the leadership of V. I. Lanerdin which was to handle both navigation and tactical tasks. Incidentally, the IL-38 was the first Soviet aircraft to have a mainframe digital computer.

In theory, after the radar operator had entered target data the computer would calculate the chances of a 'kill' with the chosen weapon; when the time was right the weapons bay doors would open and the bombs or torpedoes would be dropped automatically. This high level of automation was no small achievement at the time. In reality, however, some of the system's components proved to be extremely unreliable; unfortunately it took so long to get the system up to scratch that the Berkoot was obsolete by the time it entered service.

The SOR for the IL-38 was approved by the Soviet Air Force C-in-C on 4th May 1961. About the same time the Ilyushin OKB held a review of the advanced project in the presence of numerous invited guests. A Naval Academy representative reported on the IL-38's proposed operational ideology; the aircraft would be used mainly in the Baltic and Norwegian Seas, since the heavy ice in the Arctic Ocean rendered it unusable there. The aircraft were supposed to operate singly.

The absence of defensive armament on the IL-38 was a departure from the general Soviet trend, causing many surprised comments. However, Sergey V. Ilyushin quickly showed that the critics were wrong. Even the simplest twin-cannon tail barbette with ammunition would weigh at least 1,500-1,800 kg (3,310-3,970 lb) and require an extra crew member, to say nothing of the ground support personnel. Besides, the aircraft would need a gun laying radar which, apart from adding still more weight, might cause problems with the MAD. Worst of all, all this trouble would not really do anything by way of self-defence. Ilyushin's opinion was that all-aspect air-to-air missiles were the solution but no such weapons were available for heavy aircraft at the time.

Ilyushin was supported by AVMF Commander Air Marshal Ivan I. Borzov, Hero of the Soviet Union. Borzov was convinced that ASW aircraft were designed to operate outside the envelope of the enemy's air defences and fly at low level to ensure stealth and thus had no need for defensive armament; to reinforce his point he referred to the IL-38's US counterpart, the Lockheed P-3, which had no such armament. The latter argument was somewhat shaky, since the Orion would be operating within the reach of friendly air defences and thus was safe from attack by enemy fighters. However, Borzov was known for his explosive temper and tenacious memory, and no-one commented, feeling that silence would be safer.

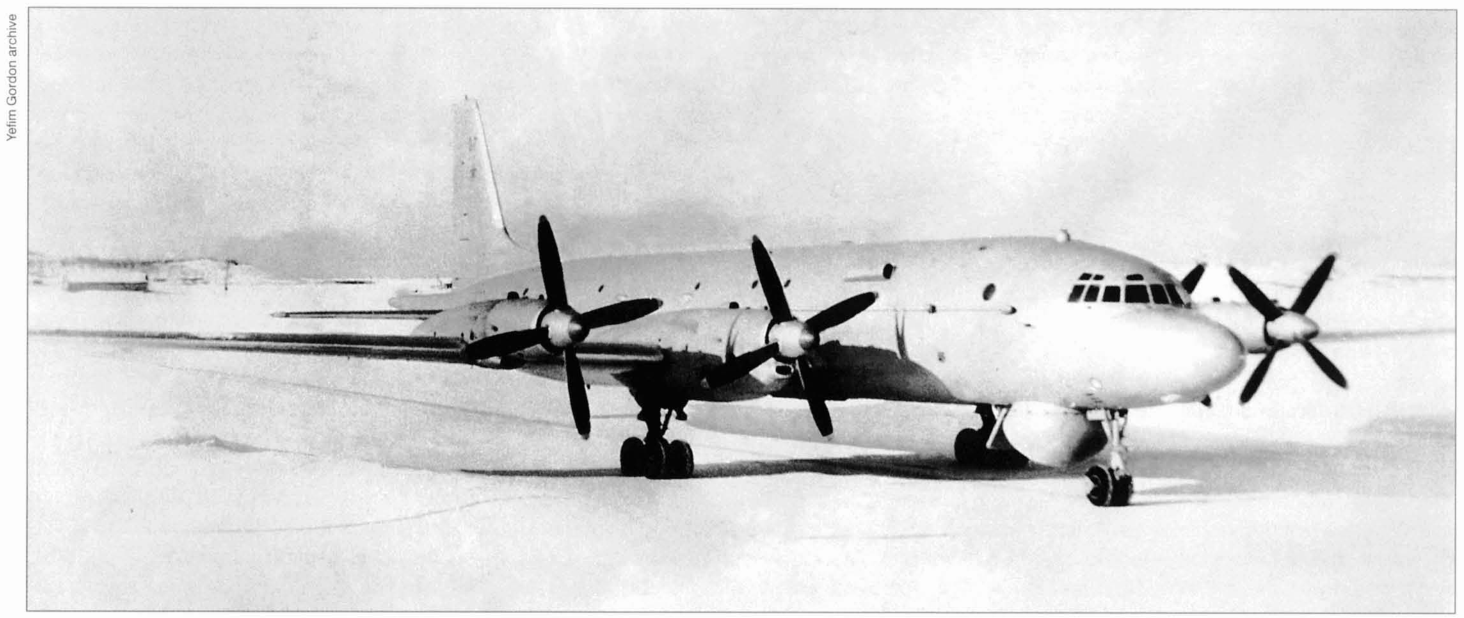
The Western press wrote that the P-3 would be armed with McDonnell Douglas Astronautics Company (MDAC) AGM-84 Harpoon air-to-surface missiles with a range of 110-120 km (59-65 nm) and thus have strike capability. This caused considerable interest among the Soviet military who asked Ilyushin to incorporate similar weapons on the IL-38. Ilyushin promptly replied that the draggy external stores would cause too much stress on the wings, which were heavily loaded as it was.

A complete set of technical documents for IL-38 prototype construction was released in a remarkably short time. The prototype was built at the OKB's experimental shop, MMZ No.240 at Moscow-Khodynka.

Prototype construction proceeded quickly, thanks in no small part to the production plant's director P. A. Voronin. Standard IL-18 components were pulled off the nearby MMZ No.30 'Znamya Truda' production line and taken across the field to MMZ No.240 for conversion and assembly. The aircraft was completed without the Berkoot STS, some components of which were then being tested on the IL-18SL avionics testbed (CCCP-75643, see above)

On 28th September 1961 – almost a full year ahead of the date set forth in the government directive – the IL-38 took to the air for the first time, powered by AI-20A engines because the intended AI-20Ms were still unavailable. The aircraft was piloted by an Ilyushin OKB crew – captain Vladimir K. Kokkinaki (project test pilot), first officer Eduard I. Kuznetsov, navigator V. F. Voskresenskiy and radio operator I. S. Siliminov.

Yefim Gordon archive



'07 Red', a grey-painted production IL-38 operated by the 24th OPLAP DD at Severomorsk-1 AB. Note the open entry hatch just aft of the radome.

Armament specialist M. S. Gol'dman was appointed engineer in charge of the flight test programme. This included performance and handling trials, primarily in flight modes typical for an ASW aircraft; weapons bay operation and the possibility of bailing out through the ventral entry hatch were also checked. The designers of the Berkoot STS were to analyse the actual conditions in which their system would work later on.

Initial flight tests continued until June 1962 at Ilyushin's flight test facility at LII's airfield in Zhukovskiy south of Moscow. Meanwhile, from 15th May to 12th June 1962 the mock-up review commission reviewed the IL-38-plus-Berkoot STS advanced development project. The Navy group headed by Air Marshal Ivan I. Borzov was keen to see the aircraft enter service as soon as possible and thus provided valuable assistance in every possible way throughout the trials.

Early test flights revealed that the IL-38 rotated more easily on take-off than the IL-18 and behaved differently in a crosswind because the wings were located further forward. Originally the ventral radome was hemispherical, generating turbulence which caused minor but constant and annoying vibration of the forward fuselage. The problem was quickly rectified by extending the rear portion of the radome aft and the result was a quasi-spherical shape.

Generally the IL-38 was easy to fly, inheriting the benign handling characteristics of the airliner from which it was derived . Pilots reported that take-off and landing presented no problems and the aircraft had adequate stability and controllability throughout its speed, altitude and CG range (the CG limits were 16-30% MAC). The IL-38 showed no handling peculiarities at its never-exceed speed of Mach 0.65 and remained stable with the weapons bay doors open. Rudder and aileron authority was sufficient to counter the yaw and roll in the event an outboard engine failed on take-off.

The crew evacuation tests also went well. The bottom line was that there were no obstacles to the installation of the Berkoot STS. However, development of the latter was lagging behind schedule and proceeded in unreasonable secrecy, even by Soviet standards of the time. (LNPO Leninets engineers often travelled abroad and met foreign colleagues who offered to sell tried and tested mission equipment for the IL-38, but such a purchase was considered politically unacceptable.)

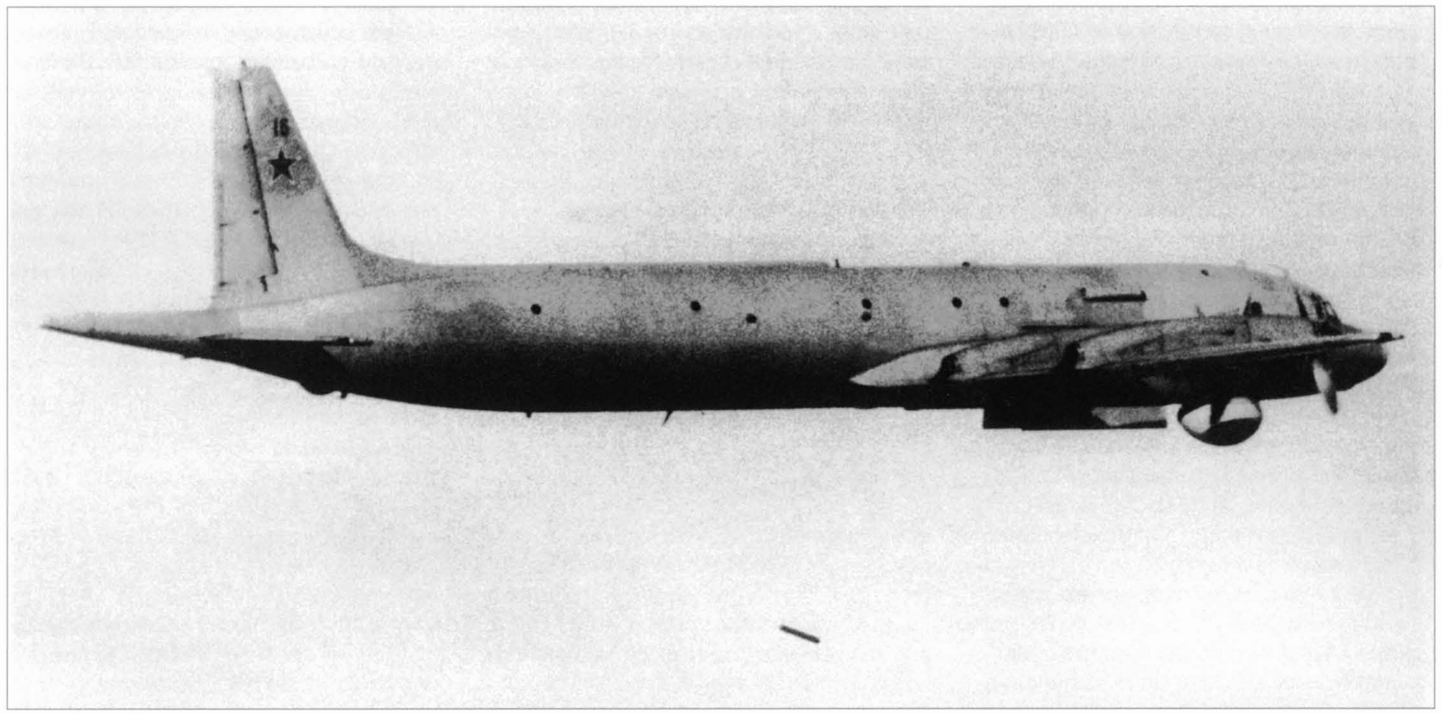
Upon completion of the manufacturer's flight tests the prototype was fitted out with all components of the STS except the TsVM-264 digital computer. The original AI-20A engines had run out of service life and so were replaced by improved AI-20Ks rated at 3,945 ehp (2,942 ekW). Stage 2 of the trials programme began on 10th March 1963 – almost a year behind schedule; the objective was to verify the Berkoot STS jointly with LNPO Leninets and to check out the possibility of carrying various models of sonobuoys.

Stage 2 was largely performed at Kirovskoye airbase near Feodosiya on the Crimean peninsula which was managed by Section 3 of NII VVS. This time Aleksandr M. Tyuryumin (also Ilyushin OKB) was project test pilot, while M. S. Gol'dman remained engineer in charge. The tests showed that the search radar, the ARI and other elements of the STS worked well but the RGB-1 sonobuoys were ill-suited to cold-weather operation. At this stage the IL-38 logged 369 hours in 147 flights.

Now the final step had to be taken: the computer had to be installed and all systems integrated and debugged. This stage of the work dragged on until February 1964; next month Stage A of the tests began at Kirovskoye AB under the supervision of GK NII VVS team chief Col. Ye. B. Polyakov. While Soviet Navy test pilots confirmed the company's high opinion of the aircraft itself, the Berkoot system started misbehaving. Avionics failures were encountered in virtually every single flight; the TsVM-264 computer and the sonobuoys proved particularly troublesome.

Despite the fact that some 200 defects were discovered at this stage and had to be eliminated, Stage B of the tests began on 14th May 1965. This time the GK NII VVS team was headed by Col. O. A. Voron'ko; Lt. Col. A. K. Kiryukhin was engineer in charge of the Berkoot STS and the aircraft was flown by Col. S. M. Sookhin and Lt. Col. A. F. Stepanov.

The State acceptance trials finally took place on 6th June – 15th December 1965; the IL-38 logged 287 hours in 87 flights; 80% of the time the aircraft worked in co-operation with surface ships and submarines used as practice targets. The results of the trials were analysed on 1st-4th December by the State commission chaired by Air Marshal



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Seen from a shadowing NATO aircraft, IL-38 '16 Red' drops a sonobuoy retarded by a drogue parachute from the forward weapons bay.

Ivan I. Borzov. The commission ruled that the IL-38 should be put into production at MMZ No.30 under the in-house product code *izdeliye* 8 but not officially included into the Naval Air Arm inventory for the time being because mission avionics reliability was unsatisfactory. Other deficiencies discovered during the State acceptance trials included 2,600 kg (5,372 lb) of excess weight and excessively high noise levels in the cabin caused by the forward shift in wing position.

Another problem facing the engineers was the need for a full-authority automatic propeller feathering system (the AI-20's system enabled autofeathering only at 70% nominal power or more). Sergey V. Ilyushin approached a western manufacturer (probably Hamilton Standard) with the request to supply such a system, but the sale was either vetoed or the cost proved prohibitive.

Besides his temper, Borzov was also known for his progressive approach to ASW development; he was positive that 'sub hunter' aircraft were a valuable asset and did much to see this class of weapons put into service. As chairman of the State commission reviewing the IL-38 and its STS he aided a lot in speeding up the aircraft's development and overcoming bureaucratic snags.

As was customary at the Ilyushin OKB, a full-time team was formed for turning the aircraft over to the 'customer'. The team was headed by M. S. Gol'dman and included test pilots Aleksandr M. Tyuryumin and G. N. Volokhov, and flight engineers V. Lebedev and Yuriy Grevtsev. Coincidentally, IL-38 project chief Yakov A. Kootepov formed a team of engineers which would quickly solve problems coming up during the trials.

MMZ No.30 began gearing up for IL-38 production in 1965. Production was managed by N. I. Sood'yin and A. I. Khmel'kov.

The AT-2 homing ASW torpedo which was to be the IL-38's main weapon was doing much better than the STS. Its State acceptance trials were also held at Kirovskoye AB under the supervision of Capt. 2nd Grade (the naval equivalent of Lt. Col.) L. G. Golubev. During the trials 63 live torpedoes and 19 inert torpedoes were dropped from the IL-38 prototype, as well as from a Tupolev Tu-16T *Badger-A* torpedo bomber and a Mil' Mi-4 *Hound* helicopter. The trials were successfully completed in late 1964 and the AT-2 was recommended for acceptance by the AVMF.

Meanwhile, trials and debugging of the IL-38's STS continued. The first six months of 1966 were devoted to correction of the numerous deficiencies noted during the State acceptance trials and installation of new mission avionics with improved reliability. Concurrently the interim AI-20K engines were replaced by the more powerful, reliable and fuel-efficient AI-20Ms as originally intended. This permitted an increase in take-off weight from 63,500 kg (139,990 lb) to 66,000 kg (145,500 lb) and led to a new series of performance tests.

In was not until October 1966 that manufacturer's tests of the improved Berkoot STS and armament began. Once again the test crews were facing numerous problems, as evidenced by the test log:

'...On 27th October a complex sortie was flown with the objective to seek and destroy a submarine with input from RGB-2 sonobuoys. On one of the five buoys dropped the parachute failed to open, on two others the microphone and heading indication system failed to separate after splash-down; objective not completed.

On 29th October a complex sortie was flown with the objective to seek and destroy a submarine with input from RGB-2 sonobuoys. The mission was aborted because of a TsVM-264 [computer] failure.

...On 18th November a complex sortie was flown with the objective to seek and destroy a submarine with input from RGB-2 sonobuoys; objective not completed due to sonobuoy failure.

...On 3rd December a complex sortie was flown with the objective to seek and destroy a submarine with input from RGB-2 sonobuoys; objective not completed due to failure of the Berkoot STS sensors.

...On 24th December a complex sortie was flown with the objective to seek and destroy a submarine with input from RGB-2 sonobuoys; mission aborted due to radar transmitter failure.

On 26th December a complex sortie was flown with the objective to seek and destroy a submarine with input from RGB-2 sonobuoys. Aiming accuracy was unsatisfactory – the weapon dropped 5-7 km [2.7-3.78 nm] *from the target.'*

Through most of 1967 LNPO Leninets kept working on improving the reliability of the prototype's STS, in particular the TsVM-264. On the ground the computer was inspected and checked for hours and hours, and some modules which did not meet the specifications were replaced. Still, subsequent flights showed that the computer's reliability remained as low as ever. Finally, in late October 1967 the STS trials with the prototype were halted.

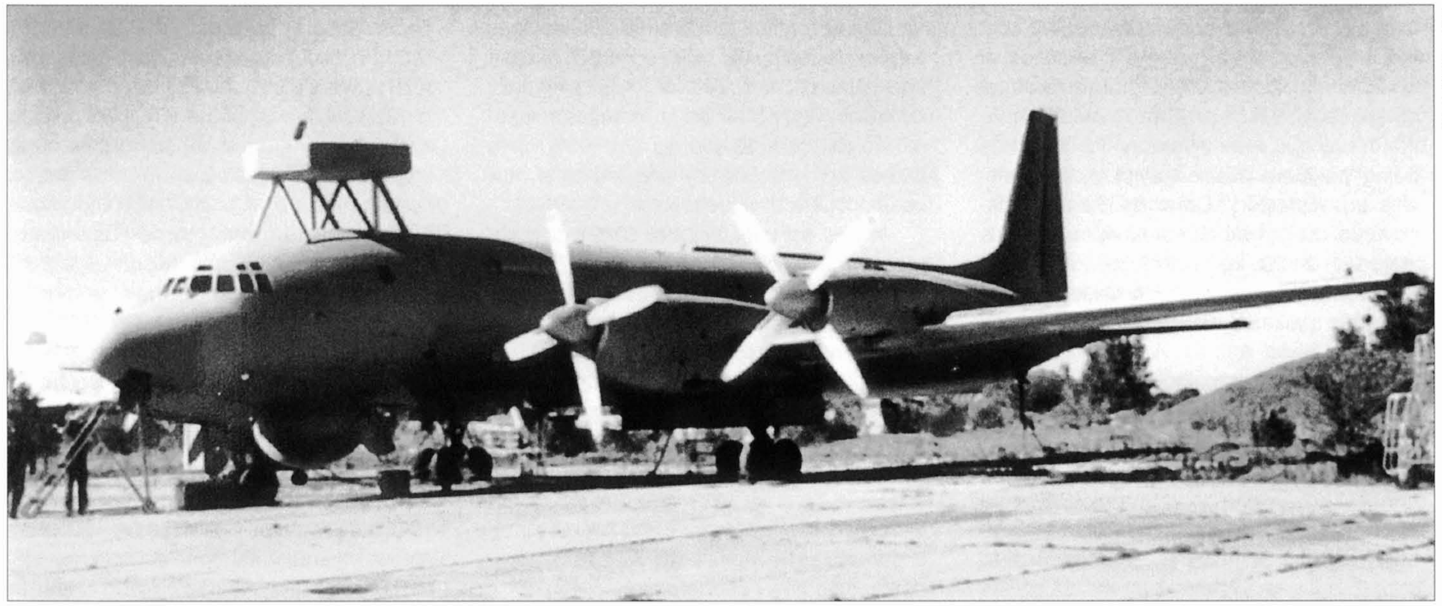
Later the aircraft served for various tests which were not included in the State acceptance trials programme for some reason. As a rule, these were highly complicated missions demanding high flying skills, such as high-alpha tests, rejected take-off (RTO) with simulated engine failure and icing tests. The safety of operations in autopilot mode at 500 m (1,640 ft) and MAD efficiency at 100 m (330 ft) were also investigated.

The main part of the STS improvement and debugging work was performed on the first production IL-38 built in 1967 (tactical code unknown, c/n 087010106). (Again, IL-38 c/ns followed the same basic system as the IL-18. In this case, it is *izdeliye* 8 (the zero is added to preserve the nine-digit format), year of manufacture 1967, MMZ No.[3]0, Batch 101, 6th aircraft in the batch. Curiously, while the IL-38 was also built in batches of five, the numbers of the aircraft in the batches went from 6 to 10 – that is, they were 'add-ons' to existing IL-18 batches!)

Between October 1967 and January 1968 the prototype was based at Kirovskoye AB where additional State acceptance trials of the Berkoot system were held under the supervision of Maj. P. K. Zamyshevskiy; Ilyushin OKB navigators V. I. Melekhin and R. B. Voronov played an important part at this stage. Unfortunately the fickle autumn weather, storms on the Black Sea and inadequate availability of support ships caused the trials to take rather longer than expected. Yet, periods when the weather was good were used to the full, with a lot of flying.

The results were encouraging and the reliability of the STS had clearly improved, even if the Berkoot still left a few things to be desired. This enabled Air Marshal I. I. Borzov to clear the IL-38 for service. As the Soviet Navy accumulated operational experience with the type, the engineers at LNPO Leninets analysed the most common defects and developed countermeasures. Finally the painstaking work of the system's designers began to yield results. On 17th January 1969 the IL-38 was formally included into the AVMF inventory – after seven and a half years of testing. The official name ran as follows: 'ASW complex – IL-38 aircraft with the Berkoot search and targeting system'.

In November 1971 Sergey V. Ilyushin, A. I. Zhukovskiy, D. I. Koklin, M. A. Kootepov and A. V. Shaposhnikov received the State Prize for the development and refinement of the IL-38. Other Ilyushin OKB employees who were actively involved in the programme included Yakov A, Kootepov, Radiy P. Papkovskiy (currently IL-38 chief project engineer), Valeriy A. Borog, Ye. I. Sankov, V. I. Smirnov, V. M. Ghermanov *et al*. A major contribution was made by AVMF Commander I. I. Borzov, naval test pilots and engineering staff, the personnel of military research establishments and service units. Many of them received due recognition for this; at GK NII VVS alone 19 aircrew members received government awards in 1969 for their part in the IL-38 programme.



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The prototype of the IL-38N (alias IL-38SD) upgraded version with the Morskoy Zmey (Sea Dragon) search and targeting suite at Pushkin during trials. The 'suitcase' on top of the forward fuselage houses a signals intelligence system antenna array.

Full-scale production was originally planned at aircraft factory No.166 in Omsk (currently OAPO 'Polyot') or aircraft factory No.126 in Komsomol'sk-on-Amur (currently KnAAPO). However, Sergey V. Ilyushin thought this was completely illogical. He addressed the Soviet government and the Communist Party Central Committee, requesting that IL-38 production be assigned to MMZ No.30 (which, as already mentioned, was building the IL-18 and would have no trouble producing its ASW derivative), and eventually got his way.

The first production IL-38 took off in September 1967; production continued until 22nd February 1972 when the 58th and final aircraft was rolled out. (Some sources say 65 IL-38s were built.) Interestingly, the original acquisition plan signed in 1962 envisaged no fewer than 250 aircraft.

The West became aware of the IL-38's existence around 1970 and the aircraft received the reporting name *May* (in the 'miscellaneous' category).

In the early 1970s a new trend originated: setting up a 'field' of sonobuoys was considered a more effective tactic of hunting submarines than the customary sonobuoy barriers. In practice this meant that buoys were evenly distributed over the entire suspicious area rather than in a line across the sub's anticipated path. Hence the TsVM-264 computer received new software for working in this mode.

In an attempt to give the IL-38 ECM capability a single aircraft was fitted experimentally with SPS-151 and SPS-153 Seeren' (Lilac) active jammers. The modified aircraft underwent tests at LII (Zhukovskiy) and at the NII VVS facilities in Akhtoobinsk (near Saratov in southern Russia) and Kirovskoye AB in 1971-72. While the ECM gear eventually was not fitted to production IL-38S, some IL-38s were retrofitted with the Vishnya COMINT system. Outwardly such aircraft could be identified by two small dielectric blisters on each side of the forward fuselage linked by a thin conduit stretching all the way aft to the wing leading edge. Some aircraft featured guidance equipment for KAB-500PL guided depth charges. During 1974 and 1975 the Berkoot STS was upgraded by the addition of the ANP-3V automatic navigation device (*avtomaticheskiy navigatsionnyy pribor*) which enabled the IL-38 to manoeuvre more accurately while tracking a submarine.

An interesting development was the attempt to increase the IL-38's range without any hardware modifications. Having learned that US Navy P-3 crews often shut down one or two engines to save fuel during ocean patrol missions, Ilyushin engineers decided to investigate the possibility of doing the same on the IL-38. To this end a test programme was held at Kirovskoye AB in 1970-72 under the supervision of Col. Apollonov. In the course of the tests GK NII VVS test pilots determined the maximum all-up weights at which the *May* could fly safely on three or two engines and worked out a reliable relight technique for the AI-20 (which, incidentally, was totally different from the one in the flight manual). A crew captained by Col. Ye. M. Nikitin investigated the worst possible scenario (when the aircraft was flying on the two outboard engines and one of them failed) and developed recommendations for service crews what to do in this situation. (It should be noted that even this scenario did not cause imminent danger of a crash.)

Generally the results were encouraging – shutting down one engine increased on-station loiter time by 20-30%. A side effect of this technique was that the pitch change mechanisms had to be filled with a higher-grade oil with better low-temperature performance to make sure it would not congeal when the propellers were feathered. Still, this method did not find practical application with the IL-38.

IL-38M and IL-38MZ development aircraft

Another (and obvious) way of increasing range and endurance was to give the IL-38 in-flight (IFR) refuelling capability. Work in this direction began at the Ilyushin OKB in the autumn of 1971 under the leadership of the new General Designer Ghenrikh Vasilyevich Novozhilov (previously Sergey V. Ilyushin's deputy; Ilyushin had retired in 1970 due to poor health). The actual design effort was led by V. M. Ghermanov.

The probe-and-drogue IFR system already used by the Soviet Air Force's strategic bomber arm, DA (*Dahl'nyaya aviahtsiya* – Long-Range Aviation), and the AVMF was selected. Two versions of the aircraft were developed simultaneously: the IL-38M (*modifitseerovannyy* – modified) and the IL-38MZ (*modifitseerovannyy/zaprahvshchik* – modified/tanker). The former was merely a receiver aircraft equipped with a fixed refuelling probe ahead of the flightdeck glazing on the port side, while the IL-38MZ also had a 'buddy-buddy' tanker capability. To this end additional fuel tankage and a UPAZ-38 hose drum unit (*ooniversahl'nyy podvesnoy agregaht zaprahvki* – versatile suspended refuelling unit) were installed in the weapons bays. The HDU was a product of OKB-918 led by Guy Il'yich Severin. This bureau later became the *Zvezda* (Star) company best known for the K-36 ejection seat which is fitted to almost all current Russian combat aircraft.

To ensure accurate rendezvous even in the most adverse weather both aircraft were fitted with the RSBN-20V SHORAN system. The IL-38M's maximum all-up weight (not the maximum take-off weight!) increased to 69,000 kg (152,120 lb). Any production IL-38 could be easily converted to IL-38M/IL-38MZ standard if need arose.

Stage A of the IL-38M's State acceptance trials proceeded at Kirovskoye AB between October 1974 and June 1975, followed by Stage B from November 1976 to May 1977. The aircraft clocked 271 hours in 117 test flights.

Various locations for the refuelling probe and associated piping were tried; the aircraft sported black phototheodolite calibration markings on the forward and centre fuselage and the inboard engine nacelles. The refuelling equipment was evaluated at various speeds and altitudes in various weather conditions, day and night; incidentally, the IL-38M was the first Soviet aircraft to make a night-time fuel replenishment using the probe and drogue system. Various refuelling system failures were simulated and a new and simpler refuelling technique developed.

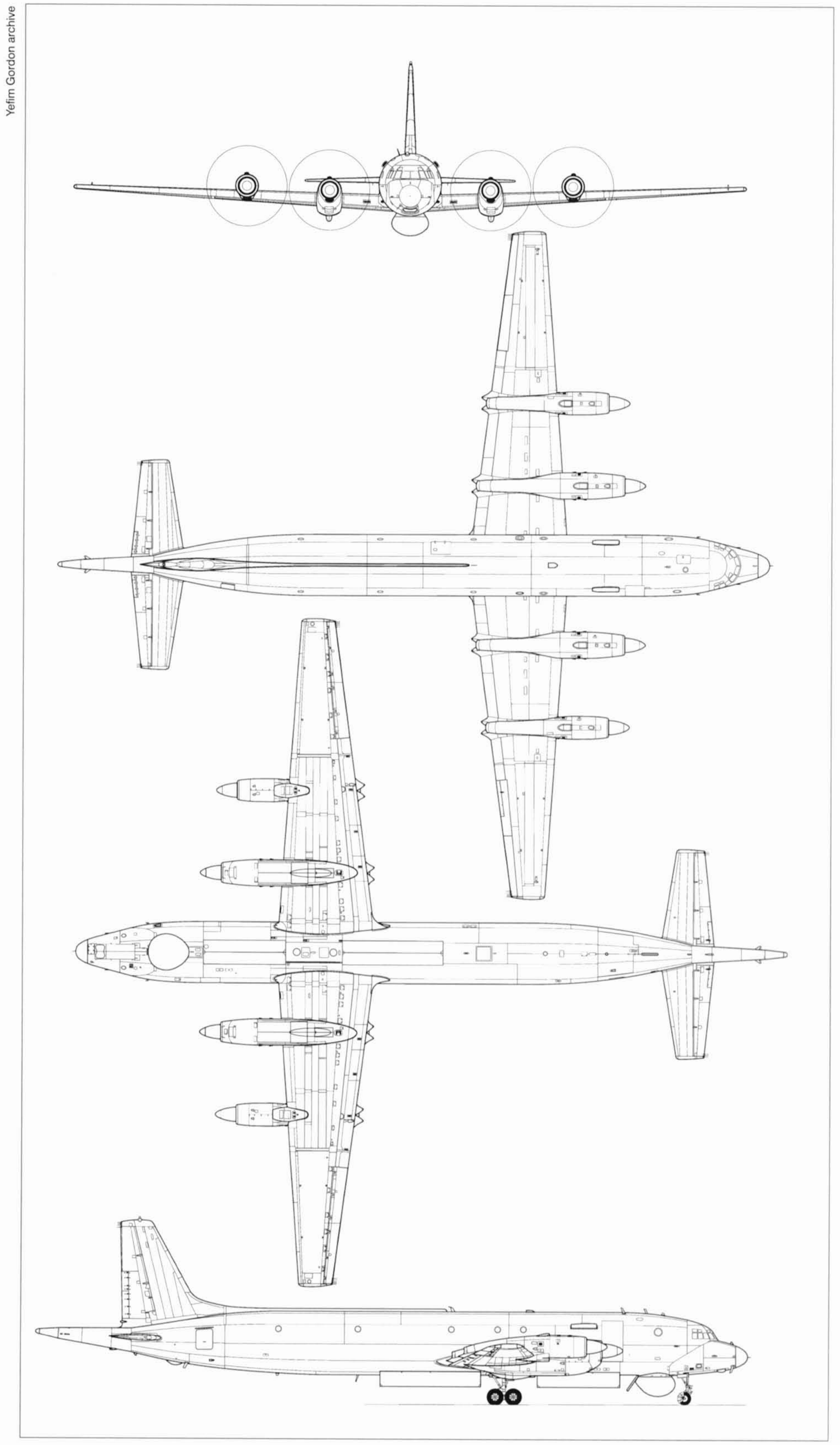
Tests showed that the system increased the IL-38's on-station loiter time by 1.5 to 2 hours; the fuel transfer rate was 1,000 litres/min (220 Imp gal/min). The IL-38M and IL-38MZ were recommended for AVMF service but never got there.

Officially the reason was that the Navy didn't care for the idea of having part of the IL-38 fleet (which was small as it was) converted to tankers and thus made unavailable for ASW duties. However, there were persistent rumours that Andrey N. Tupolev had had a hand in the matter to clear the way for the Tu-142. There were reasons for this suspicion, as Tupolev was known to trip up competitors in this fashion, using his influence. (The Sukhoi T-4 bomber which was rejected in favour of the less advanced Tu-22M *Backfire* is a case in point.)

IL-38 test and development aircraft

One IL-38 was used by LNPO Leninets as a testbed for the Korshoon (Kite, the bird) search radar developed for the Tu-142M. This had previously been tested on the company's SL-18P avionics testbed (see above).

Another IL-38 'fell victim' to *konversiya* (the adaptation of military assets for civilian needs). In the late 1990s the Leninets Holding Company converted it into a geophysical survey aircraft equipped with the IKAR (Icarus) multi-mode survey system developed under F. F. Zolotookhin; the IKAR acronym stands for *izmeritel'nyy kompleks aerogheograficheskoy razvedki* – aerogeographical prospecting measurement suite.



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Four views of the IL-38.

The IKAR system enables all-weather high-resolution scanning of land and sea, making the demilitarised *May* suitable for such varied tasks as geological mapping, oil and ore prospecting, magnetic and laser scanning of the coastal seabed, searching for submerged objects such as sunken ships, maritime search and rescue, fishery

reconnaissance and so on. The latter is important, since at least one of the two IL-18DORRs (CCCP-75462, c/n 187010304) had been reconverted to IL-18D standard by then, leaving the long-range ocean fishery reconnaissance role sorely 'understaffed'.

IL-38N (IL-38SD) ASW aircraft

Given the protracted economic crisis in Russia which effectively rendered development and production of 'clean sheet of paper' ASW aircraft impossible, an increase in the nation's ASW and maritime patrol capabilities could only be obtained by an in-depth modernisation of the IL-38. This implied first and foremost installation of a new mission avionics suite and possibly new engines (the same ideology as used by Lockheed in its P-7 Super Orion project).

In 2000 the Leninets Holding Company completed development of the *Mor**skoy** Zmey* (Sea Dragon) new-generation STS. Unlike the Berkoot STS, the new system was not centralised but featured a 'federal structure' with several independent data gathering/processing subsystems integrated into a single whole and governed by an Argon mainframe computer. The system's modular structure with duplicated hardware and software maximises the chances of mission success even if some of the components fail.

The Morskoy Zmey (also known under the code letter 'N') comprised a new search radar with a mechanically scanned slotted-array antenna and a 25-kilowatt transmitter. The installation of the new radar did not necessitate any changes to the radome's shape. The radar exhibited high resistance to jamming and had track-while-scan capability. Targets with a radar cross-section of about 1 m² (10.75 sq ft) could be detected at a maximum range of 30-35 km (18.6-21.7 miles).

The new radio/hydroacoustic subsystem had 96 channels for receiving and processing data supplied by sonobuoys. The system was worked by two operators and consisted of two modules, each of which could work with up to eight buoys at a time. These comprised RGB-41 passive non-directional buoys, RGB-48 passive directional buoys and RGB-58 active emitting buoys. The buoys weighed from 10 to 16 kg (22-35 lb), with a diameter of 120-150 mm (4¾-6 in) and a length of 1-1.26 m (3 ft 3⅜ in. to 4 ft 1⅛ in). Special RTB-91 magnetometric buoys were also envisaged; according to other data, the system was to include a new MAD with a detection range of 900 m (2,950 ft).

An ELINT package was installed in a flattened pod mounted on lattice-like struts above the forward fuselage. It had a 360° field of view, scanning signals with a frequency range of 0.5-40 GHz. The aircraft also featured a gyrostabilised optical/thermal imaging system for detecting and tracking surface targets. The system could be trained manually or automatically.

The mission crew consisted of two tactical information processing system operators and a third operator for the search radar and ELINT system. The joint workstations were equipped with a large colour liquid-crystal display and LCD control panels.

Designated IL-38N, the uncoded prototype of the IL-38/ Morskoy Zmey upgrade (c/n unknown) entered flight test at Pushkin in 2000. The new system was advertised at the MAKS-2001 airshow in Zhukovskiy (14-19th August 2001). Due to the system's English name the upgraded *May* is also known as the IL-38SD (for Sea Dragon).

IL-38 upgrade projects

Several attempts to enhance the IL-38's capabilities were made over the years. As early as 30th April 1969 MAP issued an order to upgrade the *May*'s mission equipment with a view to enhancing the aircraft's search capabilities and extending its combat radius; the SOR for this was signed on 5th September. The upgrade was dictated by the changing conditions in which the IL-38 was to operate and early operational experience with the type.

A little earlier, in March 1969, the Navy had formulated an SOR for the Tu-142M's Korshoon-1 STS and it was deemed advisable to install this promising new system on the IL-38 as well. The version for the IL-38 would be slightly different and bore the designation Korshoon-M. The IL-38 would be armed with RGB-75 infrasonic sonobuoys having a detection range of 20-30 km (10.8-16.2 nm) instead of the RGB-1's 1-2 km (0.54-1.08 nm). These would be used in conjunction with explosive sound sources (ESS) – bomblets creating an acoustic signal which was reflected from the target and picked up by the buoys, allowing 'quiet' submarines to be detected.

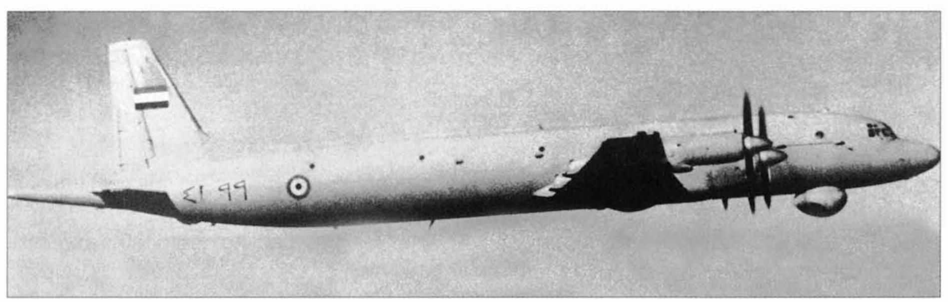
The Korshoon STS featured eight parallel data processing channels, allowing incoming signals from the buoys to be analysed much quicker. Finally, it included a tactical information display subsystem (TIDS) which used a preset range of commands stored in the mainframe computer.

The APM-60 MAD would be replaced by the more advanced Bor-1S (Pine forest) model then under development (this later received the service designation APM-73S). New navigation and flight instrumentation systems would be fitted; the standard electric/hot air de-icing system would be replaced by an electro-pulse de-icing system and the extremely inconvenient electric engine starting system by air starters (which, incidentally, would give a 340-kg/749-lb weight saving). No crew members would be 'automated away' during the upgrade; however, since mission time would increase the crew would work in shifts (that is, a relief crew would be carried).

Additionally, the aircraft would have an automatic flight control system (AFCS) replacing the Put'-4B-2K compass system and AP-6Ye autopilot, a Roomb (Cardinal point) attitude and heading reference system (AHRS) replacing the TsGV-10 vertical gyro, hydrological survey equipment, ASO-2B chaff/flare dispensers and so on. In reality, however, only the MAD was replaced. The reason was that the existing TsVM-264 computer was incompatible with the Korshoon system and would have to be replaced, which involved a lot of work. It's a shame that the work was never done; there was sufficient funding available and the result would have been worth the effort.

The next attempt at upgrading the IL-38 centred on introducing new sonobuoys – this time RGB-16 broad-band (5 Hz-5 kHz) non-directional passive buoys which had passed their tests in 1984; these were also to be used in conjunction with ESS. Replacing the Berkoot STS completely turned out to be too expensive and it was decided to add new components instead. This resulted in the *Izum**rood*** (Emerald) system which included a 68-channel Volkhov receiver (named after a Russian river), hydroacoustic data processing and display equipment, an interface with the existing Berkoot STS and RGB-16 sonobuoys.

The State acceptance trials programme included 20 flights totalling 58 hours. It showed that detection range was increased several times but the ESS bomblets were extremely impractical. Part of the IL-38 fleet was later upgraded to this standard, with encouraging results.



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Several Soviet Navy IL-38s wearing Egyptian markings for appearance's sake, including this aircraft serialled 4299, operated from Egyptian bases in the mid-1970s.

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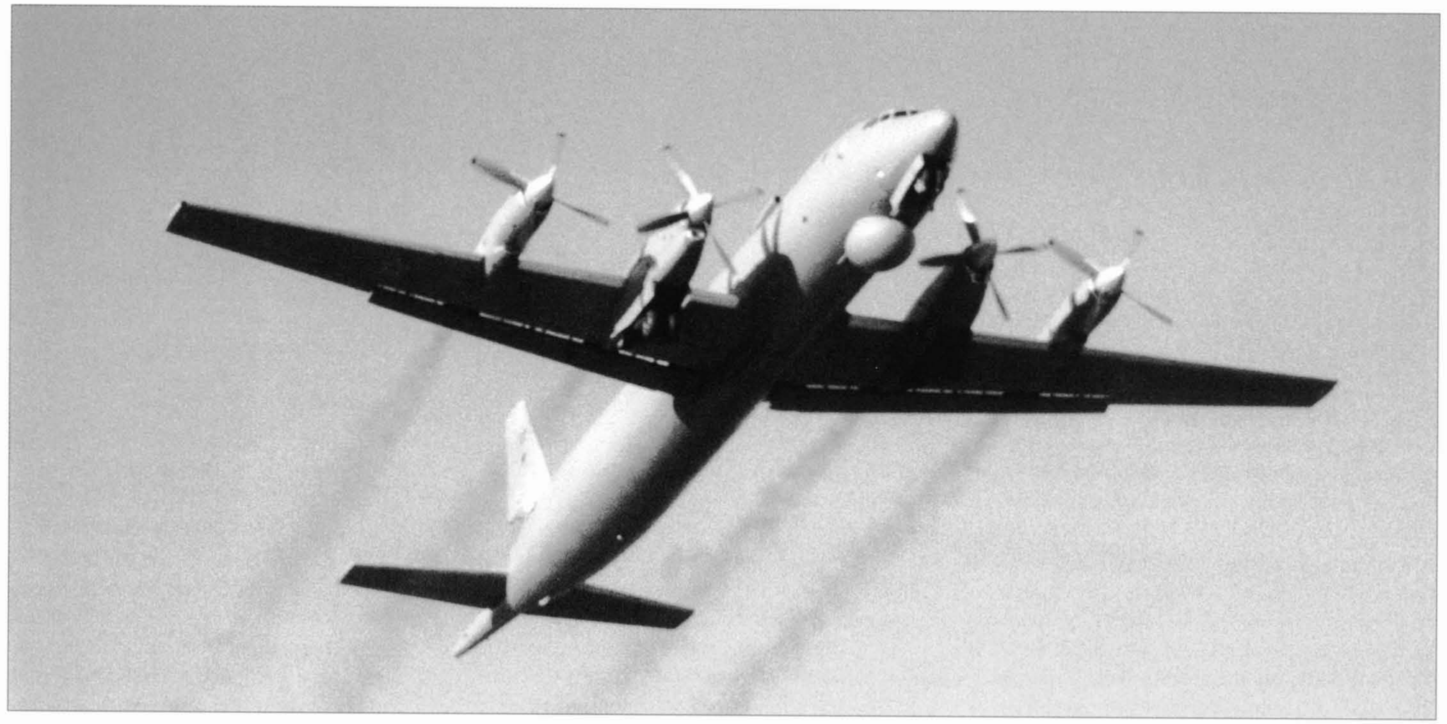

Landing gear tucking away, an IL-38 leaves a heavy smoke trail as it takes off on a training mission.

The *May* in service

IL-38 deliveries to the newly-formed 24th OPLAP DD (*ot**del'**nyy protivo**lod**ochnyy **avi-apolk dahl'**nevo **dey**stviya* – Independent Long-Range ASW Regiment) stationed at Severomorsk-1 AB near Murmansk began in March 1968. Initial operational capability (IOC) was achieved by August.

At the same time conversion training got under way at the 33rd TsBP i PLS (*Tsentr boye**voy** podgo**tov**ki i pere**oo**chivaniya **lyot**-novo sos**ta**va* – *Combat & Conversion Training Centre*). To cut costs and hasten the training process the engineers of the Centre's research and development section (Col. V. V. Achkasov, Oleg K. Denisenko and Capt. Magadeyev) devised the ***Ber**eg*-38 (Shore-38) simulation system which enabled IL-38 crews to practice using the Berkoot STS on a land test range without actually dropping sonobuoys or weapons.

In July-August 1969 the Pacific Fleet's 77th OPLAP DD based at Nikolayevka AB near Vladivostok, also a new unit, was equipped with the IL-38. The Baltic Fleet followed suit three years later when the *May* became operational with the 145th OPLAE (*ot**del'**naya protivo**lod**ochnaya **aviaeskad-ril'**ya* – Independent ASW Squadron) based at Riga-Skulte. Additionally, two aircraft were retained by the 33rd TsBP i PLS, one to three aircraft were perpetually used for test and development work by NII VVS; finally, one retired aircraft went to the Loogansk Military Navigator School as a ground instructional airframe.

The first real target (that is, foreign submarine) was detected by a North Fleet *May* in 1968 in the Barents Sea. The Pacific Fleet opened up the score in 1974 in the Sea of Japan and the Baltic Fleet two years later in the Indian Ocean.

In 1969-81 the Soviet Navy IL-38s made a total of 4,095 sorties, logging 24,540 flight hours. 172 foreign submarines were detected during this period.

The IL-38 was very much a 'pilot's airplane' and popular with flight and ground crews alike for its excellent reliability and ease of maintenance. No fatal crashes occurred with the type in Soviet times, and only one aircraft was written off in a non-fatal accident – and even that was caused by pilot error.

As noted earlier, the Berkoot STS and associated sonobuoys were the IL-38's primary means of target detection. The low reliability of the TsVM-264 computer discovered at an early test stage was to plague the IL-38 throughout its service career. True, reliability did improve over the years but still the crews preferred to rely on their skills and experience when hunting submarines.

The APM-60 MAD was used only as a secondary instrument, since its detection range was little more than 500 m (1,640 ft). Besides, it could not tell a submarine from a sunken ship; as a result, the MAD often gave false alarms in the shallow Baltic Sea littered with wrecks and other junk. It was a different story in the northern part of the Indian Ocean where the IL-38 also saw service. The Indian Ocean is much deeper and any sunken ships would be resting far below 500 m.

The outrageously expensive and unreliable RGB-3 active sonobuoys were used extremely rarely, while the RGB-2 passive buoys were mostly used during weapons practice.

Torpedo bombing practice in all Soviet Navy fleets took place at least once or twice a year. Since real operational submarines were usually used as practice targets (disposable old hulks weren't too many, after all), the *Mays* were armed with inert torpedoes.

Much attention in the IL-38 crews' combat training programme was given to setting up minefields, carrying out practice bomb strikes against surface ships and using the oldest anti-submarine weapon – depth charges. The 250-kg (551-lb) PLAB-250-120 Lastochka depth charges packed quite a punch and were to be dropped in sticks, with each charge set at a different depth

The *May*'s weapons range also included the KAB-500PL Zagon guided depth charge; like the AT-2 torpedo, this had an acoustic guidance system and featured small rudders on the nose which enabled it to follow a spiral trajectory after splashdown.

In the event of a serious war threat the Soviet Navy placed high hopes on nuclear depth charges. Using these weapons required concerted action by a group of ASW aircraft.

The nuclear munitions had a complex safety system and the detonators could only


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'22 Red' (c/n 08...011006), a 240th GvOSAP IL-38 which took part in the RIAT'96 show at RAF Fairford. Note the tail artwork. The propellers are painted bright blue, an unusual shade. The sticker on the nose is a memento from RIAT'96.

be armed by entering secret codes received en route from the General HQ in Moscow. No full-scale 'nuclear scenario' exercises are known to have taken place in the Soviet Navy; training for this scenario was limited to mission preparation (including engine starting) and, for the two bomb-toting aircraft, the flight to the storage depots where dummy nukes would be fitted.

Generally the *May* was quite effective as compared to other Soviet ASW assets; for example, the IL-38 and Be-12 were responsible for up to 80% of the 'enemy' submarines detected by the Soviet Navy in 1989. This high efficiency resulted mainly from intensive crew training.

Maritime reconnaissance was also an important part of the IL-38's responsibilities; to this end some aircraft were retrofitted with the Vishnya COMINT system, as noted earlier, and the ARI operator training course amended accordingly. ELINT-configured IL-38s routinely shadowed NATO warships.

Besides operating from their regular bases, the *Mays* were often deployed to 'friendly nations' to extend their reach. In March 1968 the Soviet Union and the Arab Republic of Egypt signed an agreement enabling a detachment of six Soviet Navy Tu-16R *Badger-E/F* ELINT aircraft to operate from Egyptian bases, gathering intelligence for both nations. The Badgers were later joined by An-12BK-IS *Cub-C* ECM aircraft, Be-12s and IL-38s. The aircraft were flown by Soviet crews but wore Egyptian Air Force markings.

Starting in the autumn of 1970, the quasi-Egyptian IL-38s performed ELINT duties over the Mediterranean. On the pretext of filling the need for more sophisticated equipment the original pair of *Mays* was supplemented in June 1971 by two more aircraft, while the Be-12s returned to the Soviet Union.

In late 1972 relations between Moscow and Cairo soured, making the detachment's further stay in Egypt impossible, and all 90th ODRAE ON aircraft returned to the USSR. In the course of their operations from Mersa Matruh the *Mays* had 20 reported contacts with submarines. More foreign deployments followed in the early 1980s, involving IL-38 crews from all fleets. IL-38s were regularly deployed to Libyan and Syrian bases; among other things they kept an eye on US Navy battleships (USS *New Jersey* etc) taking part in the 1982 war in Lebanon.

From 9th January 1980 onwards Baltic Fleet/145th OPLAE IL-38s were deployed in South Yemen (People's Democratic Republic of Yemen). Originally they were based in Aden, patrolling the Arabian Sea and the northern part of the Indian Ocean; in 1983 they moved to the major airbase at El Anad. Two Soviet Navy IL-38s were stationed in South Yemen at any one time; the aircraft and crews were rotated on a bi-monthly basis. The IL-38s were mainly tasked with locating and monitoring US Navy carrier groups.

From 29th January 1981 onwards, 145th OPLAE IL-38s were also periodically deployed to Asmara, Ethiopia (or, to be precise, the Eritrea province which later gained independence). From there they likewise flew reconnaissance sorties and patrolled the Arabian Sea.

The Soviet Union's desire to maintain a military presence in the Mediterranean led to the signing in 1982 of an agreement with Libya enabling two IL-38s to operate from Maitiga AB. During this deployment the IL-38s flew only a few sorties, detecting one submarine with the help of the mission equipment and another visually (that is, catching it in the surfaced position). IL-38s were periodically deployed in Libya in later years.

The IL-38 was also used in the maritime SAR role. To this end a large teardrop-shaped KAS rescue capsule (*kas**set**a ava-**reey**no-spa**sah**tel'naya*), misidentified as a second radome by Western observers, could be carried under the forward weapons bay and paradropped to people in distress.

North Fleet IL-38s participated in the failed attempt to save the crew of the Soviet nuclear-powered missile submarine SNS *Komsomolets* (K-278) which suffered a catastrophic fire in the Norwegian Sea on 7th April 1989. Three and a half hours after the submarine's SOS had been received the *Mays* appeared on the scene. Having spotted the *Komsomolets* in the surfaced position and established radio contact with her, the IL-38s dropped rescue capsules and circled over the area, acting as communications relay aircraft and guiding surface ships towards the stricken sub. The capsules fell some 20 m (66 ft) from the submarine but the exhausted and frozen sailors were unable to use them.

The intensity of IL-38 operations mounted steadily, reaching its peak by the early 1990s. The demise of the Soviet Union, however, changed things abruptly. Some of the *May*'s bases and training centres were located in Latvia and the Ukraine – that is, outside Russia which happened to be the only republic of the former Soviet Union interested in the type.

The 145th OPLAE was the first to fall victim to this situation. In 1992 the unit vacated Riga-Skulte AB and was disbanded next year; most of its aircraft were transferred to the 24th OPLAP DD at Severomorsk-1 AB and the 77th OPLAP DD at Nikolayevka AB. A few went to the newly-formed Russian Naval Aviation Training Centre at Ostrov AB some 40 km (25 miles) from Pskov, that is, the 240th GvOSAP. There were changes in the Pacific Fleet, too. After the Be-12s based at Yelizovo (a combined civil airport and military base near Petropavlovsk-Kamchatckiy) had been written off as time-expired, several 77th OPLAP DD IL-38s were permanently stationed there.

The Ukraine has no further use for its *Mays* and the aircraft based in Nikolayev and at Kirovskoye AB are sitting idle, awaiting scrapping.

The much-improved relations with the NATO (that is, until Operation *Allied Force* in March-June 1999) and the Partnership for Peace programme have made possible things which would have been unthinkable just ten years ago. For example, in 1995 a *May* coded '71 Red' (c/n 082011207) made an official visit to Elmendorf AFB, Alaska. The standard overall light grey colour scheme was livened up for the occasion, with a Russian double-headed eagle superimposed on a large Russian flag on the lower half of the fin and *Aviatsiya VMF Rossii/Russian Navy* titles on the forward fuselage. In the summer of 1996 another IL-38 coded '22 Red' (c/n 08...011006) participated in that year's Royal International Air Tattoo at RAF Fairford, one of the most prestigious military airshows.

When Yevgeniy M. Primakov was appointed Prime Minister of Russia, the Russian armed forces stepped up their activities somewhat. This also applied to the IL-38s which resumed their patrol sorties. Considerable importance was attached to the latter during the war in Yugoslavia which caused a temporary cooling off in the relations between Russia and the NATO.

On 31st July 1998 the North Fleet held a major exercise led by Defence Minister Marshal Igor' Sergeyev. The exercise also involved several *Mays* which dropped depth charges on the place where a Blue Force submarine was supposed to be.

In conclusion it can be said that the IL-38 may be long in the tooth, having first flown 38 years ago, but it is no dead lion. The *May*'s service life (40,000 hours) is immense by Russian military aviation standards and the aircraft has an excellent reliability record; thus the IL-38 is pretty much guaranteed to soldier on into the 21st century. Besides, as already mentioned, the Leninets Holding Company is developing upgrades for the type, including the Morskoy Zmey new-generation STS which will meet the latest demands; airframe changes and new engines are also under consideration. Still, it all depends on whether sufficient funding can be found...

IL-38 in detail

Type: Four-engined anti-submarine warfare aircraft. The airframe is of all-metal construction and is broadly similar in design to that of the IL-18. The crew of seven comprises the captain, co-pilot, navigator, flight engineer, radio operator, search radar operator and aircraft receiver/indicator operator.

Fuselage: Basically similar to that of the IL-18; the skin thickness varies from 1.2 to 2 mm (0.047-0.078 in). The duralumin reinforcement plates on the fuselage sides in the propellers' plane of rotation are attached between frames 10-12.

The centre fuselage (frames 3-56) is divided into two sections by a flat pressure bulkhead at fuselage frame 10. The front portion, together with the forward fuselage, makes up the pressurised crew section comprising the flightdeck and the aft-facing mission equipment operators' workstations; it also accommodates the radar set of the Berkoot search radar. Instead of the IL-18's glassfibre radome, frame A of the unpressurised nose fairing grafted onto the forward fuselage carries a two-piece nosecone, only the front portion of which is dielectric.

The flightdeck roof features an emergency exit offset to port between frames 4-6 to be used in the event of a wheels-up landing. An entry/escape hatch with a hydrauli-


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Part of the hardstand at Ostrov, showing two of the Russian Navy Combat & Conversion Training Centre's IL-38s. The glossy finish on the 'airshow' example makes a striking contrast with the other aircraft.

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The *May* operates in close co-operation with 'friendly' ships, as seen here.

cally-actuated forward-opening door (doubling as a slipstream deflector for bailing out) and a sloping chute, both of which incorporate recessed steps, is located on the forward fuselage underside between frames 8-10; in flight the upper end of the chute is closed by twin doors forming part of the crew section floor. Immediately ahead of the entry/escape hatch (frames 3-7) is a faired mounting ring for the revolving antenna of the search radar and associated radome. Two full-size windows of 400 mm (1 ft 3¾ in) diameter are located on each side of the forward fuselage aft of the flightdeck between frames 5-6 and 7-8 to provide natural lighting for the mission equipment operators; the rear pair is placed higher up.

The rest of the fuselage is unpressurised, accommodating the weapons and systems, and is accessible from the crew section via two doors in the rear pressure bulkhead leading to walkways running along the sides. Access is possible in flight after the pressure has been equalised. Two weapons bays closed by double doors are located in the centre fuselage fore and aft of the wing torsion box carry-through structure between frames 10-19 and 27-40; the doors are hydraulically actuated and may be manually opened 180° on the ground for maintenance. The space between frames 12-17 above the No.1 weapons bay is occupied by two fuel tanks. Five smaller windows of 300 mm (11⅞ in) diameter are located on each side of the centre fuselage. The port side features an oval emergency exit (incorporating the No.3 window) located over the port wing between frames 24-25 and a life raft bay closed by a downward-opening cover aft of the wing trailing edge (and the No.5 window) between frames 32-34. A dorsal spine fairing made of glassfibre runs along the fuselage from frame 31 all the way to the fin fillet.

The rear fuselage is almost identical to that of the IL-18, except that it terminates in a tapered boom 5.59 m (18 ft 4 in) long attached at frame 72 and featuring 17 frames; it carries the MAD sensor enclosed by a glassfibre fairing. The former rear baggage compartment door measuring 1.28 x 0.9 m (4 ft 2⅜ in x 2 ft 11½ in) to starboard between frames 58-61 is retained, acting as a service door during maintenance and as a second emergency exit.

Wings: As for IL-18, except that the wing torsion box is moved 3 m (9 ft 10⅛ in) forward, the spars being attached to centre fuselage mainframes 20, 23 and 26.

Tail unit: As for IL-18.

Landing gear: As for IL-18, except that the wheelbase is shortened from 12.755 m (41 ft 10⅛ in) to 9.755 m (32 ft 0 in).

Powerplant: As for IL-18D – that is, four Ivchenko AI-20M (AI-20 Srs VI) turboprops with a take-off rating of 4,250 ehp and a cruise rating of 2,700 ehp driving AV-68I propellers, except that the APU is installed on the port side of the centre fuselage between frames 41 and 46 (the exhaust is located between frames 46 and 47 and surrounded by a heat-resistant steel plate).

Control system: As for IL-18, except for some changes in the control runs.

Fuel system: 25 fuel tanks with a total capacity of 33,820 litres (7,440 Imp gal). Integral tanks are housed in the centre fuselage above the forward weapons bay, in the outer wing torsion boxes and the wing centre section; the inner wings accommodate bag-type tanks (fuel cells). The fuel system automatically maintains CG position as fuel is burned off.

The IL-38 has single-point pressure refuelling. Fuel grades used are Russian T-1, TS-1 or T-2 jet fuel.

An inert gas pressurisation system is provided to pressurise the fuel tanks and reduce the hazard of explosion if hit by enemy fire. Nitrogen for the system is supplied by four OSU-5 bottles installed on the starboard side near the rear entry door (frames 55-57).

Electrics: The electrical system serves for engine starting and operates the avionics, mission equipment, part of the de-icing system, fuel system components and so on.

Main DC power (27 V) is supplied by eight engine-driven STG-12TMO-1000 starter-generators; backup DC power is provided by four 12SAM-28 batteries. 115 V/400 Hz single-phase AC is supplied by four SGO-12 generators (three main units and one back-up); the AC circuits feature AZP-1SD automatic overload protection devices (*avto**maht** za**shchity** ot pere**groz**ki*). On the ground electric power is provided by the APU which drives a TS-24A starter-generator; a ground power receptacle is provided.

Hydraulics: The hydraulic system operates the landing gear, nosewheel steering mechanism, wheel brakes, weapons bay doors, propeller feathering actuators and windshield wipers. It features two NP-25-5 pumps driven by the inboard engines, two hydraulic reservoirs for the general system and two separate hydraulic reservoirs for the wheel brakes. The system uses AMG-10 oil-type hydraulic fluid; nominal pressure is 210 kg/cm^2 (3,000 psi).

Nitrogen system: As for IL-18.

De-icing system: As for IL-18. Additionally, the windscreen features an alcohol spraying system to wash away the salt building up during overwater operations at 30-50 m (100-165 ft).

Oxygen system: The oxygen system ensures crew survival in the event of decompression at high altitude and permits entry into the unpressurised centre/rear fuselage in flight. Gaseous oxygen is stored in 19 KB-1 oxygen bottles (*kislo**rod**nyy bal**lon***) installed between frames 26 and 30, 53 and 55, each holding 36 litres (7.92 Imp. gal.), and a 7.6-litre (1.67 Imp. gal.) portable bottle. KP-23 breathing apparatus with an 11 minutes' supply of oxygen are provided for the crew to ensure survival in the event of bailing out.

Fire suppression system: Three groups of fire extinguisher bottles charged with carbon dioxide for each engine. The first shot is triggered automatically by flame sensors in the engine nacelles; the second and third shots are fired manually. A separate fire extinguishing system is provided for the APU.

Air conditioning and pressurisation system: The crew section is pressurised by engine bleed air. Pressurisation air is cooled by heat exchangers located in the wing roots. A mobile air conditioning unit may be connected to the aircraft on the ground.

Armament: The IL-38 can carry AT-1 and AT-2 anti-submarine torpedoes, PLAB-250-120 Lastochka, PLAB-50 and KAB-500PL Zagon depth charges, mines and a variety of free-fall bombs. Nuclear depth charges can also be carried. RGB-1, RGB-2 and RGB-3 sonobuoys are carried for detecting submarines and homing in on them. About 30 payload combinations are possible; the maximum payload, including sonobuoys, is 8,000 kg (17,640 lb).

Avionics and equipment: The IL-38 is fully equipped for all-weather day/night operation, including automatic flight assisted by an autopilot.

Navigation and piloting equipment: The navigation suite includes an RSBN-2S Svod (Dome) short-range radio navigation (SHORAN) system with flush antennas built into the fin, a DISS-1 Doppler speed/drift sensor system (***dop**lerovskiy izme**ri**tel' **sko**rosti i **sno**sa*) with flush circular antennas under the wing centre section, an SP-50 Materik instrument landing system, an RV-4 radio altimeter, an ARK-11 automatic direction finder with a ventral strake aerial under the wing centre section offset to starboard etc. An astrosextant star tracker is mounted on the flightdeck roof between frames 4 and 5.

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'20 Red', an IL-38 belonging to the Russian Navy's 33rd Combat & Conversion Training Centre, comes in to land at Ostrov AB after a training sortie.

Communications equipment: R-847A and R-836 communications radios, a Peleng (Bearing) HF comms radio, and R-802V and R-632 command radios, served by dorsal and ventral blade aerials on the forward and centre fuselage. An SPU-7B intercom and an SGU-15 loudspeaker system (*samo**lyot**noye **grom**kogovo**rya**shcheye oo**stroy**stvo*) are provided for communication between crew members.

IFF system: SRO-2 or SRO-2M Khrom IFF transponder. The IFF aerials are located ahead of the flightdeck glazing and under the aft fuselage.

Electronic support measures (ESM) equipment: Sirena-3 radar homing and warning system (RHAWS) with aerials on the forward/aft fuselage sides and wingtips. Alternatively, some upgraded Indian Navy IL-38s have two pairs of streamlined ESM/ECM fairings on the sides of the extreme nose and at the root of the MAD boom.

Mission equipment: Berkoot search and targeting system (STS) built around a 360° search radar of the same name with a secondary weather reconnaissance function; the radar is installed in a large quasi-spherical glassfibre radome aft of the nose gear unit. APM-60 magnetic anomaly detector mounted on a boom on the rear fuselage. Some IL-38s were equipped with the Vishnya communications intelligence system with four pairs of ESM or active jamming antennas mounted ahead and aft of the wings, with external wiring conduits for the two forward pairs.

Data recording equipment: Standard Soviet MSRP-12-96 primary FDR, K-3-63 backup FDR and MS-61B CVR.

Exterior lighting: Port (red) and starboard (green) navigation lights at the wingtips; white tail navigation light under the root of the MAD boom. Retractable landing/taxi lights on the sides of the nose and under the wingtips. Red SMI-2 anti-collision strobe lights under the rear fuselage (frame 49) and at the top of the fin. Three EKSP-39 signal flare launchers on the starboard side of the aft fuselage between frames 43-46.

Survival equipment: A PSN-6A six-man life raft in a bay just aft of the port wing. The crew is provided with S-5 parachutes, MLAS-1-OB one-man inflatable life rafts and MSK-3M maritime rescue suits. Each parachute pack features an NAZ-7 survival kit.

IL-38 basic specifications

Wing span	37.4 m (122 ft 8 in)
Length overall	40.1 m (131 ft 6 in)
Height on ground	10.1 m (33 ft 1 in)
Wing area, m^2 (sq ft)	140.0 (1,505)
Maximum take-off weight, kg (lb)	66,000 (145,500)
Maximum landing weight, kg (lb)	52,000 (11,640)
Fuel capacity, litres (Imp gal)	33,820 (7,440.4)
Fuel load, kg (lb)	26,550 (58,530)
Maximum speed at 6,000 m (19,685 ft), km/h (mph)	650 (403)
Minimum loiter speed, km/h (mph)	350 (217)
Range, km (miles)	9,500 (5,900)
Combat radius with 3 hours' on-station loiter, km (miles)	2,200 (1,366)
Service ceiling, m (ft)	10,000 (32, 810)
Endurance (incl. flight from/to base), hrs	12
Take-off run, m (ft)	1,700 (5,580)
Landing run, m (ft)	1,070 (3,510)
Ordnance load, kg (lb)	8,400 (18,520)
Crew	7

IL-62 long-haul airliner

The introduction of the first Soviet turbine-powered airliners on Aeroflot's scheduled services which took place in the second half of the 1950s was instrumental in bringing about a sharp increase in the volume of passenger air traffic in the USSR; between 1950 and 1959 this traffic grew approximately tenfold. The results of forecast studies indicating a further growth of the passenger traffic volume were a determining factor in the commencement of work on a new generation of Soviet passenger aircraft which were to be considerably superior to their predecessors in performance and operating economics.

The Ilyushin OKB was the first to set about projecting such aircraft. On 26th February 1960 OKB-240's General Designer at his own initiative sent a proposal envisaging the development of the IL-62 airliner to Dmitriy F. Ustinov, Vice-Chairman of the Soviet Council of Ministers. The new machine was to be powered by four RD23-300 turbojets on which OKB-300 headed by Sergey K. Tumanskiy was working at that time. The aircraft was expected to carry 50 to 150 passengers and possess an effective range of 4,500-8,500 km (2,797-5,283 miles). This first preliminary design project of the IL-62 envisaged mounting the engines on the rear fuselage and incorporated many design features forming the basis of the IL-18 design.

Sergey V. Ilyushin's proposal was accepted, and on 18th June 1960 the Council of Ministers issued a directive stipulating that the IL-62 should have a practical range of 4,500 km and a 165-seat capacity in all-economy class configuration; in first-class configuration the figures were 6,700 km (4,164 miles) and 100-125 seats respectively). At the same time the OKB-276 aero engine design bureau headed by Nikolay D. Kuznetsov was tasked with developing the NK-8 turbofan.

The IL-62 was the first Soviet airliner project to feature engines mounted on the rear fuselage sides. The adoption of this layout made it possible to use 'clean' wings with a high lift/drag ratio so necessary for a long-haul aircraft and provide the wings with efficient high-lift devices that were required for ensuring good field performance. The engines were located some distance away from the fuel tanks accommodated in the wings and were placed aft of the pressurised passenger cabin; this made for higher safety in the event of uncontained engine failure and/or fire, reduced the noise level in the cabin and reduced the harmful influence of the jet efflux on the airframe (the vibrations that could cause fatigue problems). The engines were placed close to the fuselage axis, which lessened the thrust asymmetry and yaw in the event of an engine shutdown; this, in turn, made it possible to reduce the area and weight of the vertical tail.

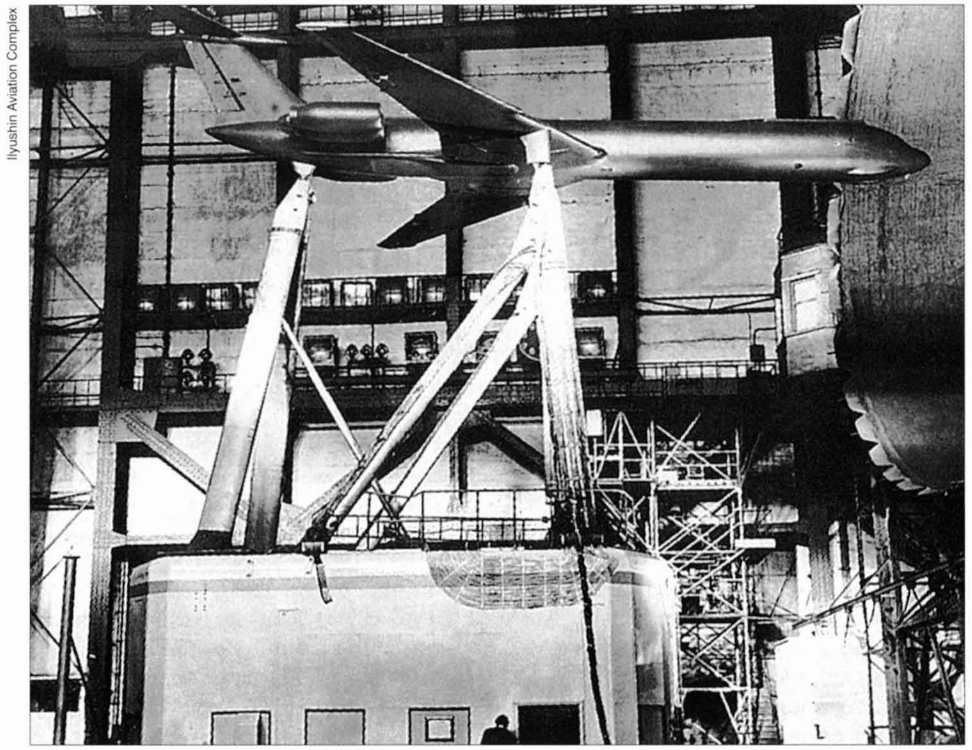
However, this engine arrangement also had certain drawbacks. These included a higher airframe weight due to the need for additional reinforcing of the rear fuselage, to the absence of compensation of the bending loads on the wings by underslung engines, and to the increased length of piping and wiring connecting the engines with appropriate systems. The CG of the empty aircraft was located farther aft as compared to layouts with fuselage- or wing-mounted engines, which created some difficulties with weight distribution within the airframe.

Nevertheless, a thorough analysis of the advantages and disadvantages of the rear-engine layout conducted during the preparation of the IL-62's advanced development project eventually corroborated the wisdom of using this layout, and it was adopted for the final version of the project, albeit a number of very complex problems had to be solved to make its implementation possible.

Design work on the IL-62 was guided by one overriding principle: it was to result in the creation of a highly reliable, comfortable and fuel-efficient airliner. In the course of preparation of the ADP Sergey V. Ilyushin decided to change the practical range and payload characteristics as compared to the figures stipulated by the government directive. He increased the aircraft's seating capacity and range in such a way as to make it competitive with the Vickers Super VC-10 which was being developed concurrently in Great Britain and which utilised the same general arrangement with low-mounted swept wings, a swept T-tail and four turbofan engines in horizontal pairs on the aft fuselage sides. In the economy-class version the IL-62 had 186 passenger seats. The fuselage had a maximum width of 3.75 m (12 ft 3⅝in) and a height of 4.1 m (13 ft 5½ in). The cabin had six-abreast single-aisle seating (3+3). Placed under the passenger cabin floor were spacious baggage compartments with a volume of 42.2 m^3 (1,490.5 cu ft). The seating capacity of the tourist-class and mixed-class versions (the latter featuring first-class seats) was determined by the customer's requirements and ranged from 168 to 122 passengers. In all configurations the passenger cabin was divided into two compartments by a centrally located galley; this facilitated the work of the flight attendants and helped avoid creating an unpleasant tunnel effect.

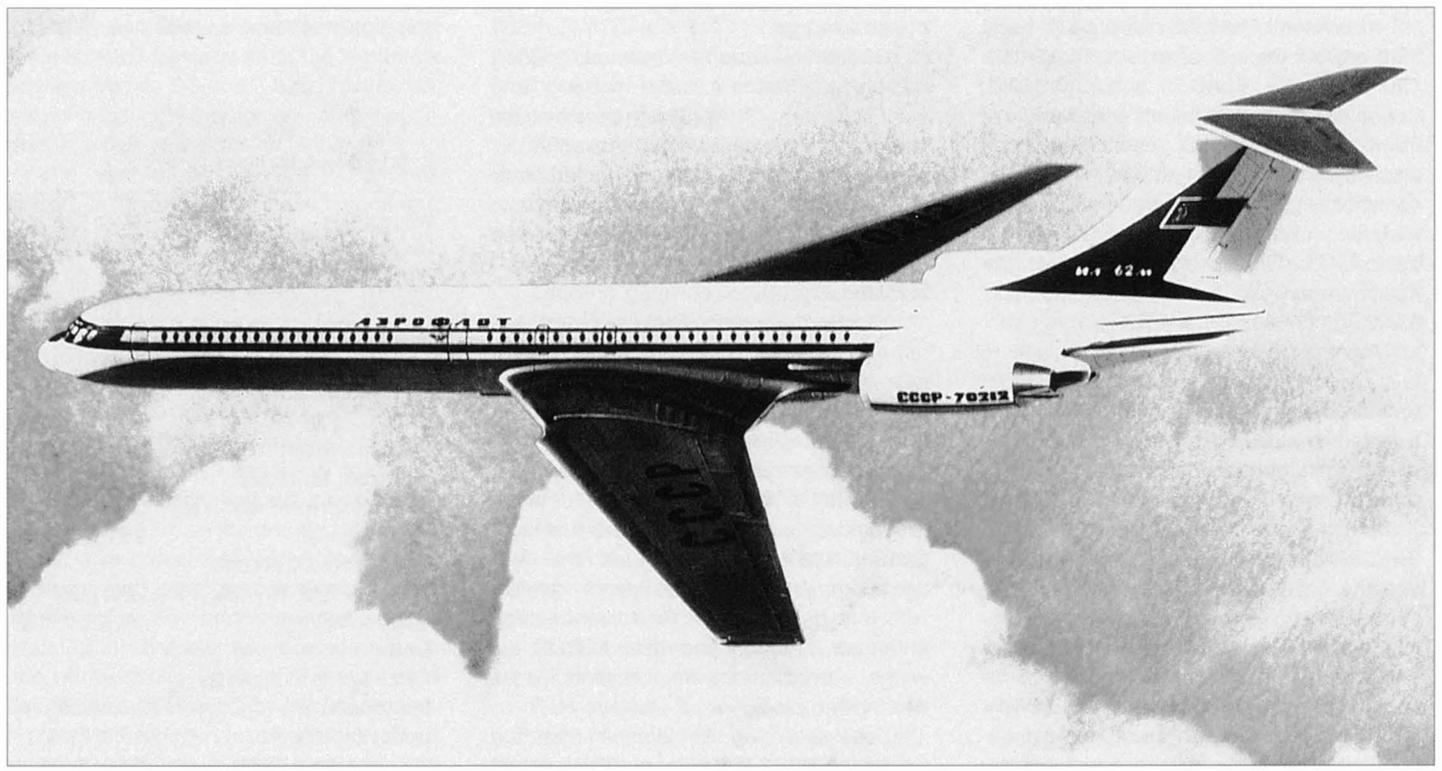
The interior decor and equipment of the IL-62's passenger cabins was developed with a view to offering the passengers a maximum of comfort in flight and furthering the principle of 'agreeable simplicity' in the decor style. In comparison with other airliners, the IL-62 featured a greatly reduced cabin noise level due to the installation of the engines on the rear fuselage. An air conditioning system comprising two simultaneously operated channels made it possible to completely change the air in the cabins up to 32 times per hour. The passengers sat in comfortable seats specially designed for the IL-62; they featured reclining backs, folding armrests and removable meal trays. The overhead baggage racks incorporated passenger service units (PSUs) with individual reading lamps and individual nozzles for cool or warm air ventilation.

Ilyushin Aviation Complex



Above: A large-scale model of the IL-62 in the TsAGI T-101 wind tunnel. Note the wing dogtooth and the fuel line conduits low on the aft fuselage sides.

The IL-62 had a crew of five: two pilots, a flight engineer, a navigator and a radio operator. They were accommodated in a spacious flightdeck affording a good field of view; all flight instruments and controls were arranged in such a way as to make using them easy and convenient. The work conditions in such a flightdeck enhanced flight safety, reducing the number of piloting errors caused by crew fatigue. Another factor contributing to flight safety was the *Polyot-1* (Flight-1) piloting and navigation avionics suite developed for the IL-62; it enabled automated and semi-automated piloting of the aircraft under adverse weather conditions and ICAO Cat 1 blind landing



Ilyushin Aviation Complex

An artist's impression of the IL-62M from the advanced development project. The registration CCCP-70212 is purely arbitrary.

Ilyushin Aviation Complex

The first prototype IL-62 *sans suffixe*, CCCP-06156 (c/n 30001), at Moscow-Khodynka shortly after the rollout. The first prototype was powered by Lyul'ka AL-7 turbojets because the intended Kuznetsov NK-8 turbofans were not yet available. Note the star tracker for the astrosextant on the flightdeck roof, offset to port.

Ilyushin Aviation Complex

Above: The first prototype at Moscow-Khodynka, with the Central Air Terminal in the background; note the small engine nacelles of the provisional powerplant. The fairings low on the forward fuselage sides enclosed escape chutes; some sources say they housed water ballast tanks, a way of overcoming the aft-CG problem.

approach. The advanced equipment also helped reduce the crew workload and ensure regularity of flight operations.

Evolving a suitable aerodynamic layout for the aircraft was among the most difficult questions in the course of the IL-62's development. Not only was this layout (and, in particular, the wing configuration) expected to ensure a high lift/drag ratio in cruise flight at Mach 0.78-0.8 and good stability and controllability; it was also required to ensure stable engine operation at high angles of attack which the aircraft could possibly assume in the event of entering a zone of intensive atmospheric turbulence with vertical gusts of the order of 16-18 m/sec (3,150-3,543 ft/min).

Proceeding from the results of extensive wind tunnel tests conducted at TsAGI, Ilyushin OKB designers chose for the IL-62 the layout of a low-wing monoplane with wings swept back 35° at quarter-chord and a swept T-tail featuring variable-incidence stabilisers (the stabiliser travel limits were 0° to -9°). To obtain the necessary centre of gravity position the wings were located well aft. The aerodynamic configuration of the wings, which had an area of 279.55 m^2 (3,009.3 sq ft), embodied the principle of combining a low-lift centre section with high-lift outer wing panels featuring a dog-tooth leading edge and leading-edge camber outboard of the dog-tooth. The dog-tooth itself was a distinctive feature of the IL-62's wing planform. When the aircraft's angle of attack approached stall, the burble on the upper wing surface began to appear in the mid-span part of the wing. The dog-tooth created a powerful vortex which localised the stall area and protected the outer wing panels from the spread of the stall, ensuring a burble-free flow over the outer wing panels up to the maximum possible angles of attack. This stalling pattern permitted a favourable change in longitudinal forces not only within the range of high beyond-stall angles of attack (18-20°) but also in deep-stall (or super-stall) flight modes with angles of attack as high as 25-45°. At these angles of attack, despite the tailplane being blanketed by the wings and the engine nacelles, the IL-62 was subjected to pitch-down forces which helped the aircraft recover from the dangerous mode and thus enhanced flight safety in extreme flight modes. Subsequent flight tests confirmed that the IL-62 possessed sufficient stability reserves and good controllability within the whole AOA range, including the beyond-stall flight modes.

True, the dog-tooth caused a slight deterioration of the lift/drag ratio in cruise flight; yet, this feature of the wing design considerably enhanced the IL-62's flight safety, as confirmed by the subsequent experience of operating a big fleet of these aircraft in the course of many years.

While the IL-62 was protected from entering the deep-stall mode by the inherent properties of its aerodynamic configuration, contemporary foreign aircraft were prone to losing longitudinal controllability when they happened to enter this mode. To prevent this, complicated hydraulic and electric devices had to be included into the control system; these included stick-shakers to warn of an impending stall and stick-pushers to prevent the aircraft from exceeding the AOA limits. The flying personnel had, putting it mildly, mixed feelings about the latter feature.

The IL-62 was a unique aircraft as far as its control system was concerned. While other comparable types of aircraft had complicated control systems with numerous actuators working the elevators, rudder and ailerons, the IL-62 was the world's only airliner in its class to possess a simple and reliable manual control system (without hydraulic actuators) in which the control surfaces were deflected only by the pilots' muscular efforts and by aerodynamic forces. This system also had the advantage of requiring only a minimum of maintenance in operation.

Ilyushin Aviation Complex

The IL-62's test crew poses for a photo. Left to right: N. F. Zotov, I. S. Siliminov, E. I. Kuznetsov, V. K. Kokkinaki, Yu. B. Küss, P. V. Kazakov and V. F. Voskresenskiy. The latter three died in the crash of this very aircraft on 25th February 1964. Note the shape of the engine nacelle's rear end and the absence of thrust reversers.

The design features incorporated in the IL-62 made it possible to reduce the horizontal and vertical tail area; yet, deflecting the elevators, the rudder and the ailerons in flight required a considerable physical effort which would not be acceptable for the pilots. These control forces were reduced to an acceptable level thanks to a large volume of research which had been conducted in TsAGI wind tunnels and in the course of flight testing; this research resulted in selecting the optimum values of aerodynamic balancing of the rudder, elevators and ailerons and the optimum shapes of their leading edges, the area of the tabs and balance tabs which ensured obtaining the minimum hinge moments.

The IL-62's high-lift devices comprised double-slotted inboard flaps (later replaced by single-slotted flaps) and single-slotted outboard flaps; there were no leading-edge devices. During landing the flaps were deflected to an angle of 30° within 20 seconds by two electric motors. Two pairs of spoilers/lift dumpers were mounted on the outer wing panels. Their simultaneous deflection to an angle of 30° in flight allowed the aircraft to descend on a steep glide slope; on landing their simultaneous deflection to the maximum angle of 60° at the moment of touchdown reduced the landing run creating a downforce and thus enhancing the efficiency of the wheel brakes. Later, after the initial flight tests, it was found advisable to make use of the spoilers also for roll control when making a landing approach with the flaps deployed. In this case the spoilers were deflected to an angle of 15° differentially (on the appropriate wing only).

Another special feature of the IL-62's basic layout was the location of the main landing gear units. The aft-mounted engines entailed a pronounced rearward shift of the empty aircraft's CG, while the embarkation of passengers and loading of cargoes had the opposite effect of shifting the CG of the fully loaded aircraft forwards. The CG positions of the empty and loaded aircraft came to be spaced rather widely. Should the main gear units be located behind the CG of the empty aircraft, in keeping with the generally accepted practice, this would result in them being placed too far from the CG in the fully loaded configuration. This, in turn, would necessitate a powerful nose-up pitching moment to execute rotation on take-off and would presuppose the use of large and heavy horizontal tail surfaces.

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The first prototype IL-62 retracts its landing gear during an early test flight. Note that spindle-shaped fairings have been added at the wingtips.

On the IL-62, in contrast to other similar aircraft of the period, the main undercarriage units were located ahead of the empty aircraft's CG (which was at 44% MAC as compared to 52% MAC on the British Vickers VC-10 featuring a similar layout), but behind the CG of the loaded aircraft. This considerably reduced the distance between the main gear units and the CG of the loaded aircraft. As a result, it proved possible to reduce the horizontal tail area considerably (it was 40 m^2 (430.6 sq ft) on the IL-62 versus 60 m^2 (645.9 sq ft) on the VC-10 – and consider that the latter had a smaller wing area); this afforded a weight saving and reduced drag in cruise flight. To prevent the aircraft from tipping over on its tail when parked or taxying in an empty condition, the IL-62 was fitted with a unique feature – a special twin-wheel fully castoring telescopic strut retracting vertically into the rear fuselage. This considerably simplified the loading and unloading of the aircraft, making it possible to conduct these operations in any sequence.

While designing the IL-62 the OKB paid much attention to cutting the aircraft's structural weight. As early as at the advanced development project stage strict weight limits were evolved for all airframe subassemblies and aircraft systems; during the preparation of detail drawings the General Designer constantly checked the observance of these limits. Creating an airframe structure with a high degree of weight perfection was facilitated by Ilyushin's decision to design an airframe capable of withstanding stresses of lesser values, while the subsequent static tests were conducted at full design stresses.

Prefabricated integrally machined panels were widely used in the airframe structure. Their use in the IL-62's wing torsion box made it possible to reduce its weight by more than 1,000 kg (2,205 lb) as compared to a hypothetical alternative riveted structure. Weight reduction was also facilitated by new production technologies: the use of computerised machine-tools for machining the flat surfaces and ribs of stamped panels with a gradual change in the thickness of their cross-sections in accordance with the value of stresses to be sustained, shaping and strengthening the outer surface of stamped panels by shot preening, the use of chemical milling of parts with integral stiffeners. Press-riveting amounted to 48% of the total amount of riveting jobs.

Four NK-8 turbofans with an initial thrust rating of 9,500 kgp (20,950 lbst) apiece and a bypass ratio of 1.02 were attached to two-arch load-bearing torsion-boxes in the engine nacelles, side by side on each side of the aft fuselage. Firewalls made of titanium separated the engines in the nacelles from each other. Large hinged cowling panels offered good access to the engines and their accessories placed in the nacelles. Maintenance of the powerplant was convenient and did not take much time. The two outboard engines (Nos 1 and 4) were to be fitted with cascade-type thrust reversers. The use of thrust reversers was a novel feature on a Soviet passenger aircraft at the time. It made landings under adverse weather conditions on wet or ice-covered runways considerably easier and safer; the same was true in the case of an aborted take-off. Thrust reversal also enhanced the airliner's manoeuvrability on the ground, especially on narrow runways; at that time this was an important feature for a heavy aircraft.

The electrical, radio and instrument equipment of the IL-62 comprised 10,035 single items, 1,860 plug connectors, 1,120 electric bulbs, 352 selector switches, 1,043 circuit breakers. The overall length of the electric wiring was 175,8 km (109.3 miles). These figures exceeded similar figures for the IL-18 by a factor of three to four; this gives an idea of how complicated the systems of the IL-62 were and what difficulties they posed as regards ensuring their reliable operation.

Despite the innovative character of the IL-62's layout and the need for a big volume of research (at that time no other Soviet subsonic aircraft could rival the IL-62 as regards

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Above: As was the case with the IL-18, for the initial flight tests the IL-62 prototype was fitted with an air data boom on the radome. The pitch and yaw vanes at the tip are closed by a protective cover in this view.

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Above and below: CCCP-06156 undergoes ground tests at Moscow-Khodynka. These views illustrate the first prototype's main landing gear design with retraction rams outboard of the oleos and complex multi-segment outer doors; the large main doors are open for inspection.

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the number of wind tunnel test hours), the OKB prepared manufacturing drawing without undue delays, and the construction of prototypes commenced.

First prototype IL-62

Less than two years after the issue of the government's directive, in September 1962, the first prototype of the IL-62 with the 'MAP-style' registration CCCP-06156 (c/n 30001 – that is, year of manufacture 1963, Batch 00, first aircraft in the batch of five) was rolled out at Moscow's Central Airfield (Khodynka). (Many aircraft operated by MAP were registered in the CCCP-061xx block.) The NK-8 engines were not yet flight-cleared, so as a stop-gap measure the aircraft was fitted with Lyul'ka AL-7PB axial-flow turbojets delivering a take-off thrust of 7,500 kgp (16,540 lbst).

To ensure crew safety during flight tests, CCCP-06153 and subsequent prototypes were equipped with flightdeck escape chutes for baling out in an emergency. These were enclosed by prominent fairings flanking the nosewheel well which became a recognition feature of the IL-62 prototypes. Some sources, however, claim these were water ballast tanks for longitudinal balancing which were relocated inside the forward fuselage on production examples to cut drag.

The first taxi runs were made at Moscow-Khodynka between 19th and 24th September; on the latter date the aircraft was demonstrated to Communist Party and Government leaders headed by Nikita S. Khrushchov. After the pre-flight checks the first prototype was dismantled and transported to Zhukovskiy to take advantage of the the LII airfield's longer runway for flight tests. On 19th December the prototype resumed high-speed runs and made the first short hops; the 34-minute maiden flight took place on 2nd January 1963. The aircraft was flown by a crew captained by test pilot Vladimir K. Kokkinaki, with Eduard I. Kuznetsov as first officer, V. F. Voskresenskiy as navigator, I. B. Küss as flight engineer and V. S. Siliminov as radio operator. P. V. Kazakov was project engineer.

Flights performed in accordance with the test programme showed that the new airliner displayed sufficiently easy handling during take-off, landing and in all other flight modes; it possessed acceptable manoeuvrability and controllability, demonstrating docile handling in the event of an engine shutdown. The first prototype attained a maximum speed of Mach 0.89.

Proceeding from the positive appraisal voiced by test pilots, on 1st February 1964 the Government took a decision to launch series production of the IL-62 at aircraft factory No.22 in Kazan'.

However, a year later, on 25th February 1965, the manufacturer's test programme suffered a serious setback when the first prototype crashed. On that day a crew captained by test pilot A. S. Lipko was tasked with performing the 127th flight at the maximum take-off weight. The aircraft became unstuck at an excessively high angle of attack and insufficient speed (later this was attributed to a surge and loss of thrust in one of the engines), brushed the perimeter fence and crashed. The test crew of ten, including navigator V. F. Voskresenskiy, flight engineers I. B. Küss and L. V. Krasnopevtsev, radio operator N. K. Belyayev, project engineer P. V. Kazakov, technician N. V. Boorov, technician S. S. Dekalenko and engineer I. P. Koorchikov, lost their lives.

Second prototype IL-62

On 30th December 1963 the second prototype IL-62 (CCCP-06153, c/n 30002) was transported from Moscow to the OKB's flight test facility in Zhukovskiy. It took to the air on 24th April 1964, slightly more than a year after the commencement of the first prototype's flight tests. The second prototype was the first example to be powered by the intended NK-8-2 turbofans with a take-off rating of 9,500 kgp (20,950 lbst); these were housed in rather larger nacelles but no thrust reversers were fitted yet.

CCCP-06153 differed from the first prototype and from subsequent machines in having half the usual number of cabin windows (the window pitch was increased twofold); in addition, it featured new ailerons intended to improve roll control.

Third prototype IL-62 and pre-production aircraft

The tests conducted on the first two prototypes (before the crash of CCCP-06156) on which the axes of engine nacelles were parallel to the fuselage axis revealed the need to reduce the influence of the wing downwash on the nacelles, as well as to eliminate the onset of high-speed buffeting caused by the appearance of stall zones on the rear portions of the engine nacelles, and to prevent the engines from running roughly when the aircraft attained angles of attack between 10° and 13°. Proceeding from the flight test results and wind-tunnel tests, measures were evolved with a view to eliminating these deficiencies. They were implemented to a full extent in the structure of the third prototype which served as a standard-setter for series production. On this machine the engine nacelles had their axes inclined at an incidence of +3°. New vertically flattened fairings were installed between the nozzles of each pair of engines. In addition, improvements were introduced into the airframe structure with a view to reducing weight; the ailerons were altered again; the rudder control channel was equipped with a damper-actuator to prevent Dutch roll (the oscillation-type directional instability caused by the elongated forward fuselage in combination with the heavy rear fuselage with its aft-mounted engines). Changes were made to the main gear units (the actuation rams were moved to the inboard sides of the oleos and the wheel well doors were simplified).

On 15th May 1965 the third prototype – again with an 'MAP-style' registration, CCCP-06176 (c/n 30003) – was transported from MMZ No.240 to the flight test facility in Zhukovskiy. Manufacturer's flight tests of this aircraft began on 28th July 1965.

On 10th March 1967 State Acceptance trials of the IL-62 were started on the third prototype; B. A. Anopov and V. V. Kozlov were appointed project test pilots. The trials were completed on 12th July, and operational trials with Aeroflot were completed on 10th August 1967. Concurrently with the

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Above: The cabins of the IL-62, looking aft, with the galley compartment in between. Typically of Soviet aircraft, different blocks of seats are upholstered in different colours to liven up the interior. Note the passenger service units under the open luggage racks.

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Top and above: The ill-fated first prototype (CCCP-06156) at the flight test facility in Zhukovskiy. Note the hinged tailcone accommodating a spin recovery parachute for low-speed/high-alpha tests. The strake aerial atop the forward fuselage and the antenna fairing extending forward from the fin root are clearly visible.

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Above: The first prototype during a late stage of the flight tests, with SPT-104 electrically-powered mobile gangways near both entry doors. The air data boom is gone but the escape chute fairings (or whatever) are still there. Unfortunately CCCP-06156 crashed immediately after take-off, leaving the crew no chance to bail out.

Sergey and Dmitriy Komissarov archive

CCCP-06156 at Moscow/Vnukovo-2, the Government VIP terminal, with runway 06-24 and the main apron at Vnukovo-1 visible beyond. This view shows well the shape and position of the wing dogtooth on this aircraft.

State Acceptance trials, four IL-62s had participated in operational trials on Aeroflot routes (these were the second and third prototypes and the first and second Kazan'-built pre-production machines registered CCCP-06170 (c/n 40004) and CCCP-06300 (c/n 40005). The operational trials had officially started as early as 11th February with the second prototype. A sizeable contribution to the development of the IL-62 airliner was made by Ilyushin OKB test pilots Vladimir K. Kokkinaki, Eduard I. Kuznetsov, Yakov I. Vernikov, Aleksandr M. Tyryumin, by GosNII GA (State Civil Aviation Research Institute) test pilots and by Aeroflot pilots N. Shapkin, M. Bannyy, B. Yegorov *et al.*

In the course of State Acceptance trials, on 4th May 1967, an IL-62 crew captained by Boris A. Anopov, Hero of Socialist Labour, performed a long-distance flight. During the ten-hour flight the aircraft covered a distance of 8,050 km (5,003 miles). On 11th July the sixth production IL-62 registered CCCP-86666 (c/n 60201) powered by four NK-8-2 Srs 3 turbofans performed a flight on the Moscow-Murmansk-North Pole-Sverdlovsk-Moscow route for the purpose of checking the pilot-ing and navigation equipment under extreme conditions. In the course of 10 hours and 48 minutes the aircraft covered a distance of 8,940 km (5,556 miles). The crews were captained by B. S. Yegorov and P. M. Mikhaïlov, Hero of the Soviet Union. The crew included a representative of the Ilyushin OKB, engineer B. D. Urinovskiy responsible for powerplant experiments.

According to the results of the State Acceptance trials the IL-62 powered by NK-8-2 engines and possessing a maximum take-off weight of 160 tonnes (352,800 lb) could carry a maximum payload of 23,000 kg (50,715 lb) to a practical distance of 6,700 km (4,164 miles), and a payload of 6,000 kg (13,230 lb) to a practical distance of 9,000 km (5,593 miles) at a cruising speed of 830-850 km/h (516-528 mph).

The maximum speed attained in the course of testing was Mach 0.88, but subsequently, in operational service, the maximum speed was limited to Mach 0.83. With one engine shut down the airliner could perform a cruising flight at altitudes up to 9,000 m (29,530 ft), and with only two engines running at altitudes up to 5,000 m (16,400 ft).

When the aircraft approached a critical angle of attack, a pronounced buffeting set in, warning the crew. Thanks to the wing leading edge dog-tooth creating a vortex the aircraft was free from a tendency to spontaneously exceed a stalling angle of attack, with an attendant loss of speed. The operational angles of attack were considerably smaller than the stalling angles, and an indicator of the maximum permissible angles of attack prevented the crew from exceeding the limit.

On 9th July 1967, during a grand airshow at Moscow-Domodedovo marking the 50th Anniversary of the October Revolution, an IL-62 piloted by Boris A. Anopov headed the column of commercial aircraft. By then the IL-62 had received the official 'title' of Aeroflot's flagship, deposing the four-turboprop Tu-114 from this position.

The Protocol on the State Acceptance trials results was endorsed on 5th September 1967. At that time full-scale production of the NK-8 powered IL-62 was already well under way in Kazan'.

IL-62 production airliner with NK-8-2 engines

The first genuinely production IL-62, CCCP-86661, was built in 1965 with the c/n 50101 (for some reason the c/n was stencilled on the airframe as 50001), and still lacked thrust reversers. Production IL-62s had a TA-6 auxiliary power unit housed in the fuselage tailcone for engine starting and air conditioning on the ground instead of the prototypes' spin recovery parachute. Each batch included five aircraft.

On 30th June 1966 CCCP-86661 was delivered for operational service to the Krasnoyarsk CAD/1st Krasnoyarsk UAD/128th Flight; on 8th September revenue passenger services on the IL-62 started first on the Moscow – Alma-Ata route, and then on other domestic and international services.

IL-62 production airliner with NK-8-4 engines

Experience gained during testing and operation of the IL-62 indicated that it was necessary to use an AC electric system on these aircraft and ensure that the aircraft and its systems fully meet ICAO standards. Measures designed to achieve this objective were fully implemented on the 13th production machine registered CCCP-86673 No.1 (c/n 70303). It was fitted with NK-8-4 engines uprated to 10,500 kgp (23,150 lbst) apiece for take-off; the engines were accommodated in nacelles having a cross-section area reduced by 1.4 m² (15.07 sq ft). Alterations were made to the wingtips: the slender bullet-shaped fairings mounted there were deleted and the wings received ordinary flat wingtips with rounded leading edges. The shape of the leading-edge dogtooth was also altered. Dimensions of entry doors and emergency exits were brought into conformity with international standards.

Flight testing of this aircraft commenced on 14th May 1968; it was conducted by OKB test pilots Yakov I. Vernikov and Eduard I. Kuznetsov, V. S. Kruglyakov being the project engineer. The greater available engine thrust led to a markedly better field performance and improved characteristics in cruise flight with one engine shut down. New entry doors and emergency exits of rectangular shape (instead of the earlier IL-18 style oval doors and exits), coupled with the onboard emergency and rescue equipment, enabled the passengers and the crew to abandon the aircraft within 90 seconds, as stipulated by international standards.

Subsequent production IL-62s incorporated the alterations introduced on the 13th production machine. In all, 97 examples of the IL-62 *sans suffixe* were built, 30 of them being delivered to foreign customers. Apart from Aeroflot, the IL-62 was also delivered to the air carriers of Czechoslovakia, East Germany, China and Poland. ČSA Czechoslovak Airlines became the first foreign customer in November 1969. Interflug, the air carrier of the GDR, received its first IL-62 in April 1970, when the 100-year anniversary of Vladimir I. Lenin's birth was commemorated. Japan Air Lines and Air France – two of the biggest airlines of that time – wet-leased IL-62s *sans suffixe* from Aeroflot and put them into operation on their long-haul services.

The IL-62 was in service on the longest domestic routes in the USSR. It was also operated on intercontinental routes to North and South America, to the Far East, the Middle East and South-East Asia.

In operational service the IL-62 earned the reputation of a highly reliable, comfortable and fuel-efficient airliner. The total number of flying hours logged per year by one IL-62 aircraft was gradually brought up to 2,300-2,500, which was comparable to the number of hours logged by the aircraft of the best foreign airlines. Making the utmost use of the operational potential inherent in the design of the IL-62, ČSA began operating the type on a 'technical condition' basis without overhauls at preset intervals. The total number of flying hours logged by this aircraft in ČSA service reached 3,000. The seat-mile costs of the IL-62 did not exceed the level reached on Aeroflot's jet airliners at that time (and were actually somewhat lower). As evidenced by operational experience, the IL-62 was a very good aircraft which had incorporated all the best features that had been evolved in the course of many years of work of the Ilyushin Design Bureau on passenger aircraft.

Series production of the IL-62 *sans suffixe* in Kazan' was terminated in 1970 due to the production entry of the improved IL-62M version.

Sergey and Dmitriy Komissarov archive

Above: CCCP-06176 (c/n 30003), the third prototype. The larger nacelles of the NK-8-2 engines are clearly visible, as is the redesigned main gear with simpler doors. The famous cheek fairings are again present.

Sergey and Dmitriy Komissarov archive

The fourth prototype, CCCP-06300 (c/n 40004), still with no APU, no thrust reversers on the outer engines and with the old dogtooth shape. Note the strake-like fairings on the inner wing underside.

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A beautiful study of an early-production IL-62 *sans suffixe* (CCCP-86664, c/n 60104). It still has the old wingtip fairings and no thrust reversers.

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Above: IL-62 CCCP-86663 (c/n 60103) manufactured on 23rd September 1966 was used for de-icing system tests, as evidenced by the black stripes on the wing leading edge. It was later delivered to the Krasnoyarsk CAD/1st Krasnoyarsk UAD/128th Flight. Note the high position of the 'IL-62' nose titles.

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This view of CCCP-86664 taxying at Moscow-Sheremet'yevo on a foggy day makes an interesting comparison with the photo on the previous page; the aircraft has been retrofitted with outer engines featuring thrust reversers. Note the oval entry doors and emergency exits.

IL-62 'Salon' VIP aircraft

The high reliability of the IL-62 airliner was instrumental in the decision to use it (and later the IL-62M as well) as a VIP aircraft for the needs of high-ranking statesmen and political figures of the USSR and the Russian Federation. These aircraft were fitted with a compartment for the so-called 'main passenger' (this could be either the head of state, or other high-ranking leaders of the country, such as the Minister of Defence). The VIP cabin comprised a rest area and a spacious conference room outfitted with telephones, TV sets and other equipment that was necessary for work during the flight. Placed aft of the main passenger's cabin were compartments for the retinue, and seats for service personnel and guards. The aircraft were provided with secure communications equipment that made it possible to maintain contact with Moscow and other points from practically any place in the world.

IL-62 'Salon' aircraft were used by Soviet leader Leonid I. Brezhnev and some other high-ranking people in the USSR. In 1970 a group of persons involved in the development of this version was awarded the Lenin Prize – one of the highest awards in the USSR at the time. The group included Deputy General Designers Ghenrikh V. Novozhilov and Yakov A. Kutepov; Dmitriy V. Leshchiner who was responsible for evolving the advanced development project; V. M. Sheinin, chief of the weight analysis group; V. I. Smirnov who headed the work on the piloting and navigation avionics suite; and A. A. Ovcharov, deputy General Designer at the Kuznetsov OKB.

IL-62 avionics testbed for LORAN and autonomous navigation systems

A number of the IL-62 airliners was converted into flying testbeds or research aircraft. One such testbed was used by the Flight Research Institute (LII) between 1978 and 1985 for testing long-range radio navigation and autonomous navigation systems. This was IL-62 *sans suffixe* CCCP-86674 (c/n 80304; it was sometimes referred to in LII's papers as 'No.304' – the last digits of the c/n). Outwardly it differed only in having a couple of inconspicuous additional antennas. The results of the work performed on this machine were used for perfecting methods of flight testing of inertial navigation systems and long-range radio navigation systems. According to some sources, CCCP-86674 was also used for testing an automatic landing approach system. A similar testbed was created later on the basis of the IL-62M (see below).

IL-62D long-haul airliner (project)

The very first flights on long-range routes performed by the IL-62 demonstrated the need for increasing the airliner's range. In 1965 the OKB studied a version designated IL-62D (***dahl'****niy* – long-range) which was intended for carrying 70 passengers from Moscow to Havana via Murmansk. However, at that time, with NK-8-4 engines, this task could be tackled only by accommodating additional fuel tanks housing 30,000 litres (6,600 Imp gal) of fuel in the aft part of the passenger cabin. Special measures were taken to exclude the risk of explosion or fire in the tanks, yet General Designer S. V. Ilyushin felt this way of achieving longer range to be inadmissible, and the IL-62D project did not proceed further.

IL-62M long-haul airliner

In the second half of the 1960s the Ilyushin OKB concentrated its main efforts on increasing the range of the IL-62 by re-engining it with the new D-30KU turbofans developed by OKB-19 under Pavel A. Solov'yov. In comparison with the NK-8-4, the D-30KU had a more than twice higher bypass ratio (2.4); its SFC was 0.71kg/kgp·h (lb/lbst·h) versus 0.81 kg/kgp·h for the NK-8-4. The new engine also had a higher take-off thrust of 11,000 kgp (24,255 lbst), which made it possible to increase the AUW slightly, and was less noisy. On the IL-62 the new engines were housed in aerodynamically cleaner nacelles and were fitted with clamshell thrust reversers which ensured a higher thrust reversal ratio as compared to the NK-8-4's cascade-type reversers and a more streamlined shape of the nacelles' aft portions.

Calculations showed that with the new powerplant the IL-62's practical range with a 10,000-kg (22,050-lb) payload could be increased to 10,000 km (6,215 miles); this would be accompanied by an improvement in the airliner's profitability, too.

On 13th October the Council of Ministers issued a directive providing for the commencement of work on an advanced version of the IL-62 powered by D-30KU engines. The new engines were installed in the 13th production IL-62 (the aforementioned CCCP-86673 No.1) which had passed tests earlier in connection with numerous modifications and improvements. In addition to re-engining, the machine was once more subjected to various modifications intended to improve its performance and provide better conditions for the crew.

The new version of the airliner was designated IL-62M (*modifi****tsee****rovannyy* – modified). The work on the creation of the IL-62M was conducted under the guidance of deputy General Designer Ghenrikh V. Novozhilov.

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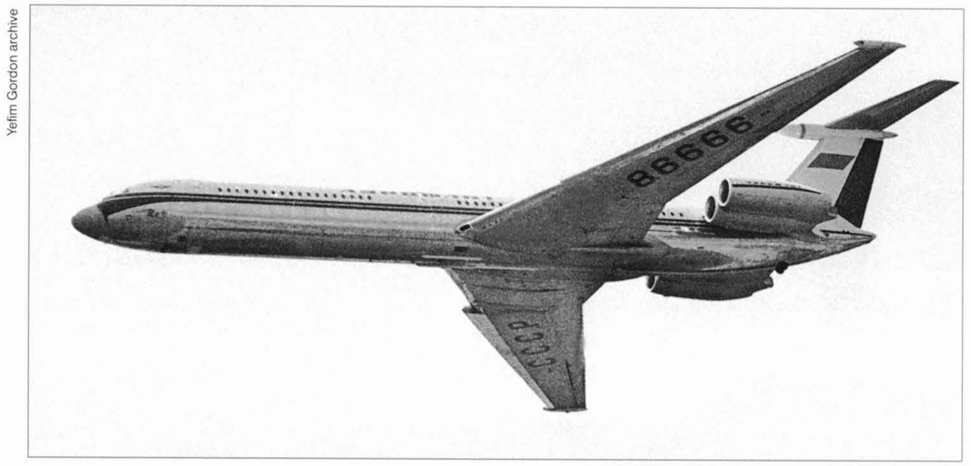
The main differences between the new version and the basic IL-62 were as follows:

- new, more streamlined engine nacelles were fitted;
- an additional fuel tank housing 5,000 litres (1,100 Imp gal) was accommodated in the fin, increasing the aircraft's range;
- roll control efficiency was increased by using the spoilers in aileron mode;
- pitch control characteristics were improved by increasing angles of deflection of the stabiliser and by by improving the shape of the elevator leading edge;
- more efficient double-slotted flaps were installed instead of the single-slotted ones;
- reverse thrust was used more efficiently;
- mechanised baggage handling was introduced;
- all systems affected by the installation of the new D-30KU engines were suitably modified;



Yefim Gordon archive

Top: IL-62 CCCP-86671 (c/n 70301) in the static park at the airshow held at Moscow-Domodedovo on 9th July 1967. The aircraft exemplifies Aeroflot's pre-1973 IL-62 *sans suffixe* livery and wears the exhibit code 230 with which it had been displayed at that year's Paris Airshow in May.
Above: IL-62 'Salon' CCCP-86666 (c/n 60201) shows off its wing planform. Three sixes, that's a cute registration.
Below: IL-62s CCCP-86653 and CCCP-86684 (c/ns 00803 and 90504) in the maintenance hangar at Moscow-Domodedovo in 1973-standard Aeroflot livery. The latter aircraft had been leased to China as [B-] 2004.

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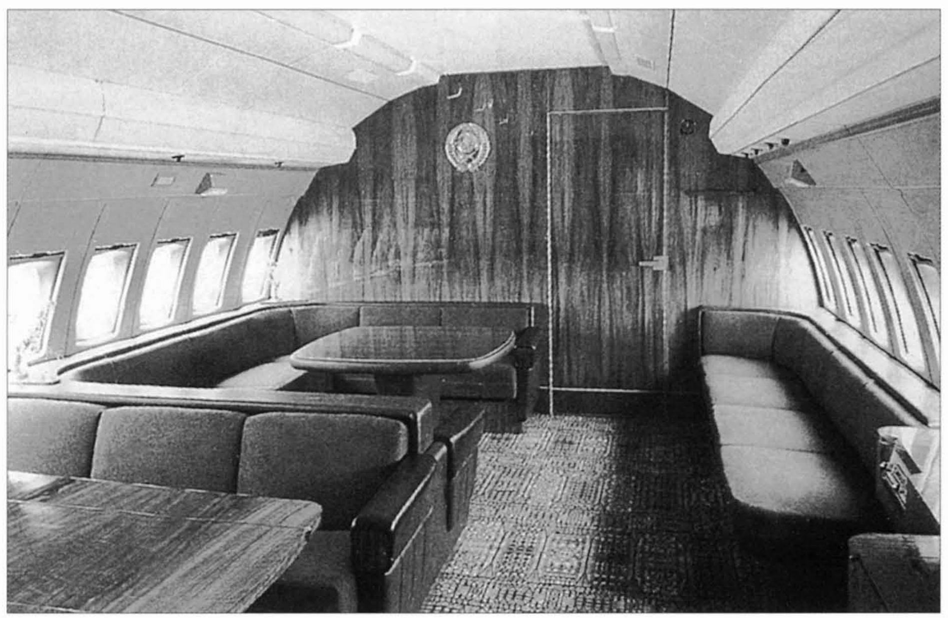
Top, centre and above: IL-62s in overt military markings are extremely rare. This grey-painted Soviet Air Force example coded '04 Red' is seen at Engels-2 AB, the seat of a long-range bomber unit. The position of the code aft of the flightdeck is unusual. Note also the rectangular doors typical of late-production IL-62s.



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The 'main passenger's cabin' on an IL-62 'Salon' with two conference tables. Judging by the Soviet state coat of arms on the cabin bulkhead, this is an aircraft operated by the 235th Independent Air Detachment (the Soviet federal government flight). The lack of the superfluous baggage racks creates a feeling of space; note the high-quality cabin trim.

- automatic stabiliser incidence control was introduced;

- new control wheels of altered shape were installed (to improve the pilots' field of view and enable a standard distribution of instruments on the pilots' instrument panel);

- an improved TA-6A APU was installed;

- some structural members of the airframe were strengthened to sustain loads associated with the increased take-off and landing weight;

- new instrument panels were installed in the flightdeck and a new instrument panel lighting system was introduced, featuring white light instead of red light;

-a more advanced piloting and navigation avionics suite and an automatic flight control system enabled the IL-62M to make a landing approach under weather conditions corresponding to ICAO Cat II.

On 5th March 1969 the IL-62M prototype (CCCP-86673 No.1) took to the air for the first time, piloted by a crew captained by test pilot Ya. I. Vernikov. V. S. Krooglyakov was project engineer for the manufacturer's tests, and V. S. Kuz'menko was project pilot from GosNII GA. The pilots noted that the IL-62M's stability characteristics were similar to those of production IL-62s within the whole range of operational CG positions, speeds and flight altitudes. The availability of spoilers functioning in aileron mode after the extension of flaps resulted in appreciably better lateral controllability at low speeds; this simplified flying the airliner in turbulence and crosswind conditions during take-off and especially during landing. This, in turn, made it possible to reduce the landing approach speed somewhat.

Changes in the techniques of using reverse thrust (the thrust reversers were actuated at the moment of passing the runway threshold and the negative thrust was brought to a maximum at the moment of touchdown) resulted in a marked shortening of the airborne part of the landing distance and in some reduction of the landing run. Test pilots stated that the layout of piloting and navigation instruments on the IL-62M's instrument panels became more convenient in comparison with production IL-62s *sans suffixe* and the revised shape of the control wheel markedly facilitated the viewing of the instruments. All this improved the crew's work conditions when flying in adverse weather, especially during landing. Replacing the red integral lighting of instruments by white lighting considerably lessened crew fatigue in long-duration night flights and facilitated access to the necessary information in flight.

Flight tests corroborated the design performance characteristics of the aircraft. Practical range with a maximum payload of 23,000 kg (50,715 lb) rose to 8,040 km (4,997 miles); with a 10,000 kg (22,050 lb) payload it increased to 10,160 km (6,314 miles). Payload at stage lengths in excess of 7,000 km (4,350 miles) (for example, on the Moscow-Montreal, Tokyo-Moscow and Moscow-New York routes) of the IL-62 could be increased by a factor of 1.45 to 1.79 in comparison with the production IL-62.

On 24th September 1969 a decision was taken to start series production of the IL-62M at the Kazan' aircraft factory. The first new-build example, CCCP-86656 (c/n 009001), first flew on 15th April 1972. For a while the two versions were produced concurrently until the IL-62M took over completely. Interestingly, later the registration CCCP-86673 was reused for another IL-62M (c/n 3154416 – that is, 3rd quarter of 1991, Batch 54, 1st aircraft in the batch, built by Team 6; the meaning of the fifth digit is unknown).

On 26th January 1970 the IL-62M prototype was submitted to GosNII GA for State Acceptance trials. Concurrently, operational trials were conducted on the first production examples. The aircraft performed transcontinental flights; their field performance, including situations with an engine failure on take-off, were evaluated in the extreme 'hot-and-high' conditions of high-altitude airfields in the hot countries of South America.

In November 1973 the comprehensive operational tests of the IL-62M were finally completed, and on 8th January 1974 the airliner began scheduled passenger services.

The experience of the first ten months of operational service with seven IL-62Ms flown by TsUMVS/210th Flight on Aeroflot's international services showed a very high dispatch reliability which amounted to 97%. On average these IL-62Ms logged 7.3 flight hours per aircraft per day. For a period of almost twenty years the IL-62M became the main Soviet long-haul airliner; for a long time it ranked first among Aeroflot machines as far as average daily utilisation was concerned. In 1997, when air transportation on domestic routes was in a state of depression, the IL-62Ms belonging to some airlines logged as many as 17 flight hours per day!

Some of the flights performed by the IL-62M were unique. On 18th June 1975 a TsUMVS/210th Flight IL-62M registered CCCP-86614 (c/n 51903) flew from Moscow to Seattle via the North Pole – a route that had previously been flown by Valeriy P. Chkalov, the famous Soviet pilot. The aircraft covered 9,480 km in a flight that lasted for 10 hours and 54 minutes. The crew captains were A. K. Vitkovskiy, Hero of Socialist Labour and Merited Pilot of the USSR (who had overall responsibility for the flight), and Yu. I. Zelenov. This flight demonstrated to the whole world the high professional level of pilots in the USSR's Civil aviation and the big potential of Soviet aviation technology. On 16th September 1977 an all-woman IL-62M crew captained by Inna Vertiprakhova established women's world speed records of 953 km/h (592 mph) on a 5,000-km (3,107-mile) closed circuit and 806

Ilyushin Aviation Complex

Above: The IL-62M prototype, CCCP-86673 No.1 (c/n 70303), with the Le Bourget 1971 exhibit code 830 and 'IL-62M-200' tail titles. Note the totally different pre-1973 livery.

Ilyushin Aviation Complex

Above and below: Beautiful air-to-air shots of CCCP-86656 (c/n 00901), the first production IL-62M. The tail titles now read 'IL-62M' (without the -200).

Ilyushin Aviation Complex

ITAR-TASS

Above: IL-62M CCCP-86499 (c/n 2932639) undergoes a pre-flight check at Moscow/Sheremet'yevo-2 on a bleak snowy day in 1980. As the 'Official Olympic Carrier' titles on the fuselage reveal, the aircraft was then operated by TsUMVS/210th Flight, carrying tourists to Moscow for the XXII Olympic Games. CCCP-86499 later passed to the Domodedovo Civil Aviation Production Association and was still in service with Domodedovo Airlines as RA-86499 as of this writing.

km/h (501 mph) on a 10,000-km (6,215-mile) closed circuit. A month later, on 23rd October, the same crew set a women's world distance record on a straight course, performing a flight from Sofia to Vladivostok. The distance of 10,086.7 km (6,269 miles) was covered at an average speed of 830 km/h (516 mph).

In the course of operational service the IL-62M repeatedly underwent updates. This version of the airliner successfully passed tests and received a certificate stating that the aircraft met ICAO standards for ambient noise. A new, reinforced wing structure was developed for the IL-62M, giving it a longer service life; as a bonus, it enabled the aircraft to fly at an increased maximum take-off weight which reached 167 tonnes (368,235 lb). The first flight of the IL-62 with reinforced wings took place on 27th April 1978.

In accordance with the programme calling for a reduction of the fuel burn and enhancement of competitiveness of the IL-62M on long-range routes, a new, so-called 'widebody look' cabin interior was developed in 1978-1979 along with new seating layouts for passenger cabins and enhanced comfort. The new interior was developed, using the experience gained in creating the interior for the IL-62M-200 and for the IL-86, the first Soviet widebody airliner. It featured a more restrained style both in geometrical contours and colours, included the use of enclosed overhead baggage bins and made use of a new material – aluminoplast (vinyl-coated aluminium). This material could be easily stamped; it possessed better durability than the Pavinol leather substitute used hitherto and obviated the need for a large amount of adjustment work in the assembly of the cabin wall trim panels.

Initially the IL-62M was operated on long-haul routes in a 158-seat tourist-class configuration and a 138-seat mixed-class configuration. Increasing the length of the passenger cabin by 2 m (6 ft 6¾ in) at the expense of shortening the galley and transferring the toilets to service compartments made it possible to increase the number of tourist-class passengers to 168 (with seats installed at 90 cm (35½ in) pitch) and the number of mixed-class passengers to 158 (with first-class seats installed at a 102 cm (40⅛ in) pitch and tourist-class seats at 90 cm pitch). These seating arrangements became the standard ones for the long-haul versions of the IL-62M.

To improve the aircraft's field performance at high ambient temperatures and reduce the fuel burn, the D-30KU engines were replaced by D-30KU Srs 2 engines maintaining a stable thrust rating at high ambient temperatures and featuring an SFC reduced by some 3%.

Much attention was paid to possible versions of the IL-62M powered by new engines. Almost every projected turbofan in the 11,000 to 13,000-kgp (24,255 to 28,665-lbst) thrust class was 'sized up' for re-engining the IL-62M. Unfortunately, projects of more advanced engines for this type of aircraft failed to reach the hardware stage at that time, despite the fact that even in the late 1970s the D-30KU turbofan no longer met the growing requirements as far as fuel efficiency and environmental aspects were concerned.

Concurrently with the efforts to extend the range of the IL-62M, steps were taken to increase its seating capacity and broaden the sphere of its operational use.

On 1st April 1993 the IL-62M inaugurated the new Moscow-Shannon-Havana-Panama-Managua-Havana-Moscow service. The inauguration of the Moscow-Johannesburg route followed on 9th April. On 24th March 1994 the IL-62M was put on regular passenger services on the Moscow-Larnaca-Sal (Cape Verde Islands)-Rio de Janeiro-São Paulo-Moscow route.

Unfortunately, airliners of this type also came to be involved – albeit very rarely – in fatal accidents. They were mainly associated with powerplant operation (uncontained engine failure, false fire warnings and the like). After the implementation of appropriate measures the IL-62M became the most reliable type in Aeroflot's fleet. Much attention was also paid to enhancing the aircraft's fuel efficiency and passenger comfort.

The IL-62M was operated in many countries of the world. Fifty-one examples of the IL-62M were delivered new to Angola, China, Cuba, Czechoslovakia, East Germany, Mozambique, North Korea, Poland, Romania; some of these countries still operate the type. A few second-hand examples were sold to other nations in post-Soviet times. At the beginning of the 21st century there were more than 20 IL-62Ms in the fleet of Aeroflot Russian Airlines. Airliners of this type serve on with various ministries, government departments and private companies.

The production run of the IL-62M totalled 193 aircraft. A few example still sit at the Kazan' factory, awaiting completion.

IL-62M 'Salon TM-3SUR' VIP aircraft

On 20th August 1976 the Council of Ministers issued a directive calling for the development of a special VIP aircraft for the 235th Independent Air Detachment based at Moscow-Vnukovo airport. The aircraft was intended for official foreign trips of the Soviet Union's top leaders; it was to be equipped with a new secure communications system.

Development of a VIP version of the IL-62M for Government use started even before the issue of the official directive, and by the end of 1976 the design work was virtually completed. This special version was a long-range airliner with several cabins outfitted with a plush interior creating enhanced comfort conditions for rest, work, for holding conferences and so on. There was also a cabin for 'the main passenger'. The aircraft was fitted with an additional navigation suite and secure communications equipment, including the 'Surgut-T' HF comms and scrambling/ descrambling suite which made it possible to maintain communications with any point in the world and to effect the conduct of state affairs from the aircraft.

The VIP aircraft was allocated the official designation IL-62M 'Salon TM-3SUR', but it is also known under the simplified appellation IL-62 'Surgut' (the M suffix is omitted for some reason). Outwardly it is identifiable by a fat dorsal fairing (housing antennas) running from the wing leading edge to the fin and a blade aerial at the top of the fin.

IL-62M 'Salon TM-3SUR' aircraft were used by Mikhail S. Gorbachov, the first and only President of the USSR, and by Boris N. Yeltsin, Russia's first President; they were used primarily for long-range travel and special mission flights. In March 1997 this very comfortable and reliable Presidential airliner was superseded by a more advanced aircraft, the IL-96-300PU 'Salon'. Nevertheless, the IL-62M 'Salon TM-3SUR' is operated by the Rossiya State Transport Co. (the successor of the 235th IAD to this day (albeit minus some equipment items) and used by other high-ranking state officials of the Russian Federation. Other examples served with the Soviet/Russian Air Force; most, however, have been stripped of the HF comms suite and transferred to Aeroflot.

On 6th November 1976 Ilyushin OKB engineers V. A. Yoodin and N. A. Bykov, who were the main motive power in the development of the IL-62M 'Salon TM-3SUR', were awarded a State Prize for their part in creating this version of the aircraft.

Dmitriy Komissarov

Above: Russian Air Force/223rd Flight Unit IL-62M 'Salon TM-3SUR' RA-86555 (c/n 4547315) basks in the sun at Chkalovskaya AB during the open doors day on 18th August 2002. The fat spine is clearly visible.

IL-62M 'Salon' VIP aircraft

The IL-62M 'Salon TM-3SUR' intended for Government use served as a basis for another VIP version designated simply IL-62M 'Salon', also to be used by the Government. It differed in lacking some equipment items (and hence the characteristic fat spine) and featured a simplified set of secure communications equipment; there were alterations in the passenger cabin configuration. IL-62M 'Salon' aircraft were operated both by the 235th IAD and by the Soviet (later Russian) Air Force. Several 'Salon' aircraft were delivered to other countries (East Germany, North Korea and Czechoslovakia) where they were used by the leaders of these Soviet allies.

A few IL-62M 'Salon' aircraft are also operated by the Rossiya State Transport Co. to this day. They are used for carrying not only high-ranking state officials but also the retinue during official visits.

IL-62M-250 medium-haul airliner (project)

On 13th October 1967 the Council of Ministers issued a directive tasking the Ilyushin OKB with the development of a 250-seat medium-haul version of the IL-62M. The higher seating capacity of this version (des-

Dmitriy Komissarov

IL-62M 'Salon' RA-86466 (c/n 2749316) taxies in at Moscow/Vnukovo-1 on 18th June 2002, displaying the current grey livery of the Rossiya State Transport Co.

RART

Above: IL-62M 'Salon' RA-86583 (c/n 1356851) is operated by Aviaenergo as the aircraft of Russian electric power tycoon Anatoliy Chubaïs in this grey/white livery with 'IL-62M/VIP' titles.

ignated IL-62M-250 in the course of design work) as compared to the baseline IL-62M was achieved by stretching the fuselage by 6.8 m (22 ft 3¾ in). The high payload of the aircraft (25-30 tonnes; 55,125-66,150 lb) was expected to increase its profitability. However, a project of a traditional narrow-body aircraft did not make it possible to solve many problems associated with its operation, and the work on this version was discontinued.

IL-62M-200 (IL-62MA) airliner

Development of the airliner version designated IL-62M-200 (IL-62MA) was prompted by the growth of the volume of passenger traffic on the trunk air routes of the USSR. The work was conducted in pursuance of the Resolution adopted by the VPK on 8th September 1969, calling for an increase in the seating capacity of the IL-62M.

Seating arrangements developed for the IL-62M-200 included a 198-seat economy-class configuration, a 186-seat tourist-class version and a 161-seat mixed-class configuration. The increase in seating capacity was obtained by deleting the coat closet and rearranging the service compartments in the rear fuselage. For the first time in Soviet practice the interior design of the IL-62M-200's passenger cabins incorporated the 'widebody look' principles and new, more advanced materials.

The IL-62M-200 was converted from the IL-62M prototype (CCCP-86673 No.1) and featured the 198-seat cabin layout with a new interior. In 1971 it was demonstrated at the 26th Paris Airshow at Le Bourget, wearing an appropriate legend on the fin.

The aircraft was subjected to lengthy joint tests by the OKB and Aeroflot; in the end the Ministry of Civil Aviation came to the conclusion that the 198-seat layout was unacceptable. Nevertheless, the experience gained in trying to increase the seating capacity and enhance the passenger appeal of the IL-62M proved to be of benefit when creating new interior variants for production IL-62Ms with other seating arrangements.

IL-62MK medium-haul airliner (project)

The IL-62M aircraft demonstrated its high economic efficiency when operated on medium-haul services, such as the Moscow-Tashkent route. Hence the Ilyushin OKB developed the project of the IL-62MK medium-haul airliner pursuant to the Council of Ministers directive dated 26th June 1974. The aircraft's field performance enabled it to operate into and from airports with runways 2,300-2,600 m (7,550-8,530-ft) long having a relatively weak surface.

The IL-62MK was to have a new 'high-flotation' undercarriage with a wider track and reduced tyre pressure and to be fitted with more powerful wheel brakes. The airliner's wings were to feature additional air brakes which would deploy automatically on touchdown. Some structural members of the airframe were strengthened to allow for the more frequent landings resulting from operations on medium-haul services necessitating higher fatigue resistance.

The standard cabin layout envisaged for the IL-62MK featured all-economy accommodation for 196 passengers; it had much in common with the layout and interior of the IL-62M-200. The greater seating capacity of the IL-62MK necessitated the provision of additional emergency exits and enhancing the efficiency of the rescue equipment.

Manufacturing drawings and other documents were duly prepared and sent to the production plant in Kazan'. However, the matter got hopelessly snared in red tape, with countless 'approvals' required to go ahead. At length, in August 1978 a decision was taken to discontinue work on this subject.

Dmitry Komissarov

The sole known IL-62MU combi aircraft, RA-86586 (c/n 3357947), is seen on approach to Moscow-Vnukovo's runway 24 on 17th March 2001 in KAPO-Avia colours.

Yefim Gordon

IL-62M 'Salon' RA-86570 *Mikhail Gromov* (c/n 1356344) begins its take-off run from runway 12 at Zhukovskiy, starting on one of its many rescue missions. This aircraft belonging to EMERCOM of Russia has often been used for evacuating refugees (not necessarily Russian citizens) from 'hot spots'.

IL-62Gr cargo aircraft (project)

In the first half of the 1990s there was a considerable growth of the share of cargo traffic in the overall volume of air traffic in Russia. In this situation some of the new air carriers that had emerged after the break-up of the Soviet-era Aeroflot felt they had a need for more cargo aircraft. The general decline in CIS aircraft production and the high prices of new-built aircraft made some air carriers turn to the time-honoured and cheaper option of converting airliners into cargo aircraft.

To meet this demand the Ilyushin Aviation Complex prepared technical documentation for converting some of the IL-62M airliners still in operation into a cargo version. Designated IL-62Gr (*groozo**voy*** – cargo, used attributively), this version featured a large cargo door measuring 3.5 x 2.0 m (11 ft 5¾ in x 6 ft 6¾ in) on the port side of the forward fuselage. The cargo hold was equipped with floor-mounted cargo-handling devices – a ball mat near the cargo door and strap-on roller conveyors with rails and locks running along the cabin floor. The cargo-handling devices were mounted on the existing seat tracks. The maximum payload carried on rigid pallets amounted to 22,300 kg (49,171 lb).

Yet, financial difficulties experienced by potential customers prevented this project from being implemented.

IL-62MU combi aircraft

The latest IL-62M off the line, RA-86586 (c/n 3357947) manufactured on 11th June 1999, was built in a combi configuration designated IL-62MU. The forward cabin serves for cargo carriage and features a reinforced floor (hence the U standing for *oo**sil**ennyy pol*) and a cargo loading device near the forward door. The aircraft is capable of carrying only small goods, as there is no large cargo door. The IL-62MU is operated by KAPO-Avia, the flying division of the Kazan' Aircraft Production Association.

Incidentally, several other IL-62Ms are operated in combi configuration, but they are not IL-62MUs, as they lack the special features.

IL-62M 'Salon'/airborne command post of EMERCOM of Russia

The Russian Ministry of Emergency Situations (*MChS Rossii*, or EMERCOM of Russia) needed a means of effecting current control over its forces committed to rendering assistance in emergency situations and to the evacuation of Russian citizens from foreign countries. In November 1995 a decision was taken to acquire a production airliner and convert for that purpose. It was to become an airborne command post for controlling and co-ordinating the actions of the rescue forces and was expected to be able to fly to any part of the globe at short notice.

Proceeding from these functions of the aircraft, the EMERCOM specialists opted for the IL-62M. However, the standard machine did not meet some of the requirements; therefore, it had to be modified into a so-called 'minor Salon' version and fitted with special avionics and equipment. This work was organised by a group of specialists from the leading departments of EMERCOM under the guidance of Rafail Zakirov, chief of the ministry's aviation department. The aircraft had to be fitted with low-noise engines and piloting, navigation and communications equipment meeting world standards.

As regards the engines, standard production D-30KUs were found acceptable if fitted with hushkits. It was not so easy with the comms and navigation equipment. It proved impossible to find Russian-manufactured systems that would meet international standards concerning navigation accuracy, the degree of automation, reliability and ergonomics. The specialists of the task group, after a thorough analysis, came to the conclusion that it was necessary to make use of equipment manufactured by Honeywell Electronics. Equipment produced by other manufacturers (Bendix or Collins) possessed closely comparable functional characteristics and was similarly priced; however, unlike its competitors, the Honeywell company guaranteed the necessary engineering support, the possibility of acquiring complete sets of equipment and of minimising the number of constituent items, the volume and the price for the same mission type. The company also guaranteed low operating costs.

As a result, Honeywell outfitted an IL-62M registered RA-86570 (c/n 1356344) and christened *Mikhail Gromov* (EMERCOM has a tradition of naming its aircraft after famous pilots) with a set of equipment which provided global communications via satellite and enhanced flight safety. The onboard satellite communications equipment working in conjunction with the Inmarsat system enabled the aircraft's passengers to maintain both clear text and coded telephone communication with telephone users on the ground and to transmit two fax messages simultaneously on two channels in any combination, as well as to transmit information

Dmitriy Komissarov

Above: Today many of the surviving IL-62Ms are operated in combi configuration, including this Russian Air Force/223rd Flight Unit example, RA-86496 (c/n 3829859) seen on finals to Moscow-Vnukovo's runway 24 on 17th March 2001. Incidentally, this machine used to be an IL-62M 'Salon TM-3SUR' in Soviet times.

via a digital channel. The modified aircraft was also fitted with a TCAS-2 collision avoidance system and a Mode S transponder.

Upon completion of all modifications and certification of the systems installed the aircraft was handed over to the State-run air transport enterprise of the Russian Ministry of Emergency Situations. An ICAO certificate was obtained permitting the aircraft to fly to any part of the globe where an emergency had arisen, obviating the need for any additional approvals and permissions.

This aircraft, the only one in Russia possessing such capabilities, is always kept ready to fly with three hours' notice. In the first six months of its service RA-86570 performed more than twenty flights within the bounds of Russia and to destinations abroad. It was used as a command post during the combating of forest fires in the Far East and when dealing with the consequences of a Chechen terrorist attack in Kaspiysk where an apartment house was blown up. It was this aircraft that brought the Russian Vice-Minister of Foreign Affairs to Sharjah in August 1997 and then took from there to Moscow the crew of an Airstan Airlines IL-76 freighter (RA-76842) that had escaped from Afghanistan where it had been held captive by the Taliban militia. The hopes pinned on this special missions aircraft were fully justified.

IL-62M LORAN and autonomous navigation systems testbed

As had been the case with the initial production model of the IL-62, a few IL-62Ms were used by scientific organisations as testbeds. One of these was the avionics testbed used by LII between 1984 and 1992 for researching and testing long-range radio navigation and autonomous navigation systems.

The aircraft was converted from an IL-62M 'Salon TM-3SUR' VIP transport registered CCCP-86515 (c/n 2138657) and was sometimes referred to as No.515. It took over the duties of its predecessor, IL-62 *sans suffixe* CCCP-86674 (see above). Outwardly it could be identified by a large flat-topped bulge over the forward fuselage, with a small dome on top.

The aircraft could stay airborne for up to 10 hours. It was equipped with standard avionics that were used for flights on domestic and international air routes. The flying laboratory was fitted with:

- equipment pertaining to LORAN, satellite navigation systems and inertial navigation systems;
- a container with an astrodome for testing astro-inertial navigation systems;
- means of measuring the standard-setting flight parameters (an aerial camera, flight trajectory measurement sensors and an onboard time synchronisation system);
- a data recording system;
- an onboard automated system for processing the flight test materials.

A set of programmes called 'Etalon' (Standard) was used for detailed post-flight processing of the flight research and test materials. Quick approximate analysis of the test materials could also be performed in the course of the experiment. Detailed analysis of the flight test data could be completed already two or three days after the flight.

The results of the work performed on CCCP-86515 were used in the course of introduction of long-range radio navigation systems on commercial and military aircraft (the Tu-154, IL-86, MiG-31 and others).

It is probable that this aircraft, like its predecessor, was also used in experiments with blind landing systems (a report about such experiments conducted on an IL-62 in 1988 did not identify the aircraft).

In 1993 the aircraft was stripped of its mission equipment, re-registered RA-86515 and sold to Moscow Airways for use as a passenger aircraft. Interestingly, it still retains the thick spine left from its days as a VIP aircraft with HF comms gear.

The IL-62 airliner was created 40 years ago. On 10th January 1996 a decision was taken to terminate IL-62 production at the Kazan' Aircraft Production Association named after Sergey P. Gorbunov. The total production run amounted to 290 IL-62 and IL-62M aircraft, albeit the original plans had envisaged the manufacture of a considerably smaller number. The IL-62 is the most long-lived aircraft in its class of long-haul airliners. Its British lookalike, the Vickers Super VC-10, has long become extinct, while the high-time example of the IL-62 had logged 39,026 hours by mid-1996 and had been in service for as many as 28 years by then. To this day the IL-62 remains in operation thanks to its reliability, efficiency and maintenance simplicity. Thus, the NATO reporting name *Classic* is both fitting and, for once, a compliment.

To conclude, it is worth quoting the prominent Soviet scientist, Academician Vladimir V. Strominskiy: *'The IL-62 airliner is perhaps the most outstanding creation of the General Designer* (Sergey V. Ilyushin – *authors' note*). *It incorporates lots of novel and original features not only as regards the general layout and the tackling of aerodynamic and structural problems, but also as regards details which, not infrequently, are decisive in shaping an aircraft's destiny.'*

Structural description of the IL-62

Type: Long-haul four-engined airliner. The airframe is of all-metal construction and is manufactured mainly of D-16 duralumin.

Squadron/Signal

Seen here at Zhukovskiy during MosAeroShow-92 in August 1992, IL-62M 'Salon TM-3SUR' CCCP-86515 was a navigation systems testbed, as indicated by the dorsal fairing just aft of the forward entry door.

Via Polygon Press

A three-view of the IL-62M.

The aircraft was built in several configurations which enabled air carriers to operate it with maximum profitability. The configurations differed in the number of passenger cabins, the number of seats, seat pitch and in the degree of passenger comfort.

Fuselage: Monocoque structure of elliptical cross-section, with frames, stringers made of stamped profiles, and skinning; the greater part of the structure is pressurised. The fuselage structure incorporates integral panels machined from stamped half-finished articles. Two pressure bulkheads are installed in the aft fuselage in the area where the engines are mounted. Structural members subjected to fatigue stresses are reinforced by back-up stressed members.

The fuselage is built in three sections. The *forward fuselage* accommodates the flightdeck equipped for the normal work of a crew of five (captain, first officer, flight engineer, radio operator and navigator). It terminates in a flat forward pressure bulkhead to which a dielectric radome is attached. The nosewheel well is located under the flightdeck floor.

The *centre fuselage* accommodates the forward and aft passenger cabins, with the galley compartment in between. A coat closet for for the winter coats of 125-130 passengers is located at the aft end; toilets are placed forward, amidships and aft in the cabin. Service compartments (one forward fuselage and two aft). Two inward/forward-sliding plug-type entry doors are located on the port side ahead of the wings, with two service doors to starboard; two overwing emergency exits are provided on each side.


Sergey and Dmitriy Komissarov archive

This view of the No.4 D-30KU engine being changed on Aeroflot Russian International Airlines IL-62M RA-86564 (c/n 4934734) shows the nacelle structure, the No.3 baggage door and the rear support strut.

The passenger cabins feature comfortable seats with reclining backs and folding meal trays; they are provided with overhead and individual lighting and ventilation nozzles, warm air heating and other amenities.

The No.1 pressurised baggage compartment is located under the floor ahead of the wings, with the Nos 2 and 3 baggage compartments aft of the wings. They have inward/forward-sliding plug-type doors. The mainwheel wells are located in between.

The unpressurised *rear fuselage* carries the tail unit and engine nacelles. It incorporates the No.4 baggage/cargo compartment, an avionics bay, the APU bay and the tail support strut.

Wings: Cantilever low-mounted monoplane wings. Sweepback 35° at quarter-chord, wing area 279.55 m² (3,005 sq ft).

The wings are a three-spar structure with beam-type spars, one-piece skin panels machined from stamped half-finished articles; the transverse structure comprises riveted beam-type ribs. The leading-edge and trailing-edge parts are of the usual riveted construction.

The wings are built in three pieces: the centre section, which is integral with the fuselage and carries the main landing gear units, and the outer wing panels. The outer wings have a cambered leading-edge extension, the inboard end of each extension forming a dog-tooth. The trailing edge is kinked at the inner/outer wing joint, with no sweep inboard. The wings are provided with three-piece ailerons (with trim tabs), two-section slotted flaps and two-section spoilers/lift dumpers; no leading-edge devices.

Tail unit: Cantilever swept T-tail of usual riveted construction, with a two-section rudder and one-piece elevators. The fin/stabiliser joint in enclosed by a large cigar-shaped fairing. Stabiliser incidence can be controlled within 0° to -9° with the help of an electric actuator. For higher reliability the actuator has two electric motors; should one of them fail, this does not disable the stabiliser pitch trim. The rudder has a spring-loaded servo tab; the elevators feature trim tabs).

Landing gear: Hydraulically retractable tricycle type, with free-fall extension in an emergency (aided by a mechanical system to make sure the downlocks come into action). All three units have oleo-pneumatic shock absorbers.

The steerable nose unit retracts forwards and has two 930 x 305 mm (36.6 x 12 in) non-braking wheels. The inward-retracting main units have four-wheel bogies featuring 1,450 mm x 450 mm (57 x 17.7 in) wheels with powerful multi-disc hydraulic brakes. There is a back-up nitrogen-hydraulic system for emergency braking and a separate parking brake. A castoring telescopic support strut with twin 620 x 185 mm (24.4 x 7.28 in) wheels is provided under the rear fuselage to prevent tipping over when parked or towed; it is retracted before taxying. The nosewheel well is closed by twin lateral doors, the mainwheel wells by a large door hinged to the fuselage keel beam and a smaller door hinged to the oleo.

Powerplant: (IL-62 *sans suffixe*) Four Kuznetsov NK-8-4 turbofans rated at 10,500 kgp (23,150 lbst) for take-off. Early-production machines were powered by NK-8-2 engines with a take-off rating of 9,500 kgp (20,940 lbst). The engines are mounted in pairs in two twin-engine nacelles on pylons attached to the rear fuselage. The engines are separated by titanium firewalls from the fuselage and from the compartment accommodating the fuel lines. The nacelles are of the usual riveted construction. Large hinged cowling panels afford good access to the engines and accessories and allow the engines to be extracted downwards.

The two outboard engines (Nos 1 and 4) are equipped with cascade thrust reversers.

The engines are started by compressed air fed by a Stoopino Machinery design Bureau TA-6 APU accommodated in the fuselage tailcone, with a door-type intake to port. In addition to engine starting, the TA-6 supplies electric power to the onboard circuitry and operates the cabin air conditioning system when parked on the ground.

The engine's autonomous oil system was mounted entirely on the engine itself.

Control system: Duplex mechanical control system with rigid linkages (with the exception of a small part of control linkages to the ailerons and the elevator trim tabs). To enhance reliability, the terminal lugs of cables and bolts are duplicated. Normal forces on the control column and rudder pedals are obtained without the use of hydraulic actuators. A yaw damper is installed in the rudder control channel. The stabiliser is electrically actuated, as are the trim tabs, except that the inboard trim tabs on the elevators use mechanical (cable) linkages. There are no traditional control columns – the control wheels slide in and out of the instrument panel for pitch control.

Fuel system: The fuel is housed in seven integral wing tanks with a total volume of 100,600 litres (22,132 Imp gal). Every engine is fed from its own tank, but a cross-feed system allows any engine to draw fuel from any tank. Four of the tanks are main tanks, the other three being supplementary tanks. The fuel system is automated. The fuel is pumped by electric transfer pumps from the supplementary tanks into the main ones. Each main integral tank has a section acting as a service tank and a pre-service section. Each engine is fed from its own service section by two electric pumps (for greater reliability). The pre-service section serves for measuring the exact amount of reserve fuel remaining and for ensuring a more complete consumption of fuel from the tank.

The integral fuel tanks have a double vent system (main and auxiliary). The main (forward) vent is used for ventilation of the tanks in normal flight, during climb and on the ground. The auxiliary (rear) vent is used for ventilation of the tanks during a steep glide and emergency descent.

Fuel piping and hot-air ducts are placed outside the pressurised cabin in special fairings running along the sides of the fuselage and in the lower part of the fuselage to prevent the seepage of fuel fumes or hot air into the cabin in the case of damage to the piping and ducts.

The aircraft was equipped with an emergency fuel jettison system. In case of need the fuel can be quickly dumped in flight by seven electrical pumps working in a boosted mode. The fuel jettison pipes are accommodated in the wingtip fairings.

The IL-62 has single-point pressure refuelling; it takes 30-40 minutes to fill all the tanks completely. In case of need the main fuel tanks can filled by gravity via overwing fillers. Total capacity of the integral fuel tanks when filled by pressure is 100,000 litres (22,000 Imp gal).

Hydraulic system: The hydraulic part of the nitrogen/hydraulic system of the aircraft comprised the main and auxiliary circuits. The main circuit catered for undercarriage operation, nosewheel steering, the main and parking brakes, the spoilers and the windscreen wipers. Nominal pressure in the system (210 kg/cm²; 3,000 psi) is provided by four engine-driven pumps. AMG oil-type hydraulic fluid is used.

The auxiliary hydraulic system is used for emergency extension of the main undercarriage units and for emergency spoiler control. It is fed by an autonomous pumping unit actuated by an electric motor. This system can be used as a back-up source for feeding the main system.

The nitrogen/hydraulic system caters for emergency wheel braking. The source of energy for the system is compressed nitro-


Ilyushin Aviation Complex

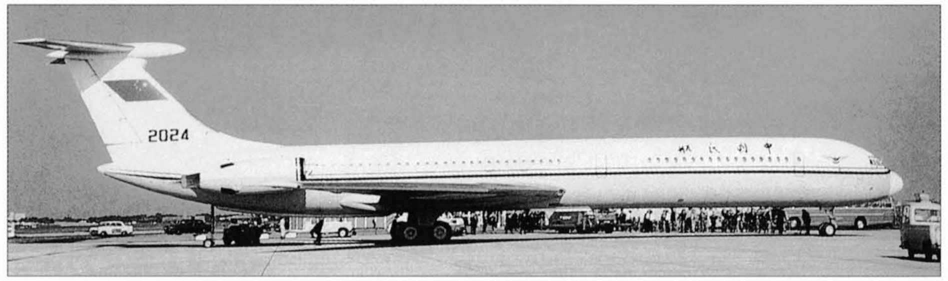
Above: The captain's seat and instrument panel of an IL-62, with the central control pedestal in the foreground. The car-type 'wheel' on the sliding control yoke is for nosewheel steering.


Ilyushin Aviation Complex

The cabin of an IL-62M offers a 'widebody look', with enclosed overhead luggage bins and indirect lighting.

Yefim Gordon archive

Above: SP-LAB *Tadeusz Kosciuszko* (c/n 21105) was the second IL-62 *sans suffixe* delivered to LOT Polish Airlines; it was sold to Aeroflot (Krasnoyarsk CAD/1st Krasnoyarsk UAD/128th Flight) in 1987 as CCCP-86706.



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Above: IL-62 '2024' (later B-2024, c/n 11005) was one of several operated by the Civil Aviation Administration of China (CAAC). It is now on display at the PLAAF Museum in Datang Shan.

Yury Kirsanov

Above: IL-62M RA-86507 (c/n 2035546) in the colours of now-defunct Moscow Airways approaches Moscow-Sheremet'yevo in 1996.

Dmitriy Komissarov

Above: Combi-configured IL-62M RA-86935 *Natal'ya* (ex-ČSA OK-PBM, c/n 1545951) at Moscow/Vnukovo-1 on 6th May 2003 in the colours of its third Russian operator, Vim Airlines.

Dmitriy Komissarov

Seen here under dreary skies at Moscow/Vnukovo-1 on 4th October 2000, IL-62M RA-86566 (c/n 4255152) of SAT – Sakhalinskiye Aviatrassy is unusual in featuring an in-flight entertainment system.

gen stored in two bottles with a total volume of 12 litres (2.64 Imp gal). The bottles are charged to a pressure of 18-20 MPa.

Electrics: The engine-driven generators serve as the main electric power source for the aircraft's systems. All the principal equipment and aircraft systems fed by the engine-driven generators are located close to the engines in the rear fuselage. This minimises the length of the wiring and enhances the reliability of the aircraft systems.

Four electric power supply systems are provided:

- the primary alternating current supply system using three-phase 200/115 V / 400 Hz AC;
- a three-phase 36 V and single-phase 27 V / 400 Hz AC system fed from the primary three-phase AC system via step-down transformers;
- a 27 V DC system.

The main sources of electric power were four three-phase AC generators with a total capacity of 160 kW. The generators were connected to the engines' accessory gearboxes via constant-speed drives (CSDs) automatically maintaining a constant frequency of the current supplied by the generators.

The 27 V DC system was fed from the primary system via transformer/rectifier blocks. Back-up 27 V DC power was provided by four storage batteries.

When the APU was running the starter-generator could function in generator mode to supply DC to the onboard circuitry. Late-production IL-62s were equipped with an APU featuring two generators – one DC generator and one AC generator.

Air conditioning system: A combined pressurisation and air conditioning system catered for the pressurisation and ventilation, heating and cooling of the pressurised cabins in flight and on the ground. The system also catered for de-misting the flightdeck windscreens, supplying the cooling air to radio equipment, and supplying hot air for the de-icing systems of the wings and the tail unit. The system was fed by air bled from compressors of all four engines. The ducting supplying the bleed air to the pressurised cabin comprised two identical and independent systems connected by a cross-feed valve. Both systems supplied 7,600 kg (16,758 lb) of air per hour to the pressurised cabins; the air in the flightdeck and in the passenger cabins could be completely changed with a frequency of up to 30 times per hour.

At altitudes up to 7,200 m (23,620 ft) the cabins pressure was constant and equalled the sea level pressure. At the altitude of 13,000 m (42,650 ft) the pressure was equivalent to the barometric pressure at 2,400 m (7,870 ft) above sea level. Air conditioning of pressurised cabins on the ground was effected either by the TA-6 APU or by a ground air conditioning unit.

De-icing system: The de-icing system protects the wing and tail unit leading edges, air intakes, inlet guide vanes and inlet fairings of the engines, windscreens and clearview windows of the flightdeck. In addition, this system protected the air intakes of the air-to-air heat exchangers of the air conditioning system placed in the wing roots. Hot-air de-icing on the wings, tail unit, engine air intakes, engine inlet guide vanes and fixed intake spinners.

Hot air with a temperature of 300°C (570°F) was bled from the last stage of the engine compressors. The temperature differential between the surface to be protected and the ambient air was sufficient to protect the aircraft from icing in all operational modes and under the adverse weather conditions that could practically be encountered. Electric de-icing on the flightdeck windscreens and direct-vision windows, as well as on the pitot/static ports.

Fire suppression system: The fire suppression equipment ensured the extinguishing of fires inside engine nacelles, inside the engines and in the APU bay, as well as filling the integral fuel tank in the wing centre section under the fuselage with inert gas.

Equipment: The aircraft was fitted with the Polyot-1 piloting and navigation avionics suite which ensured automated and semi-automated flight in adverse weather conditions and ICAO Cat 1 blind landing approach capability.

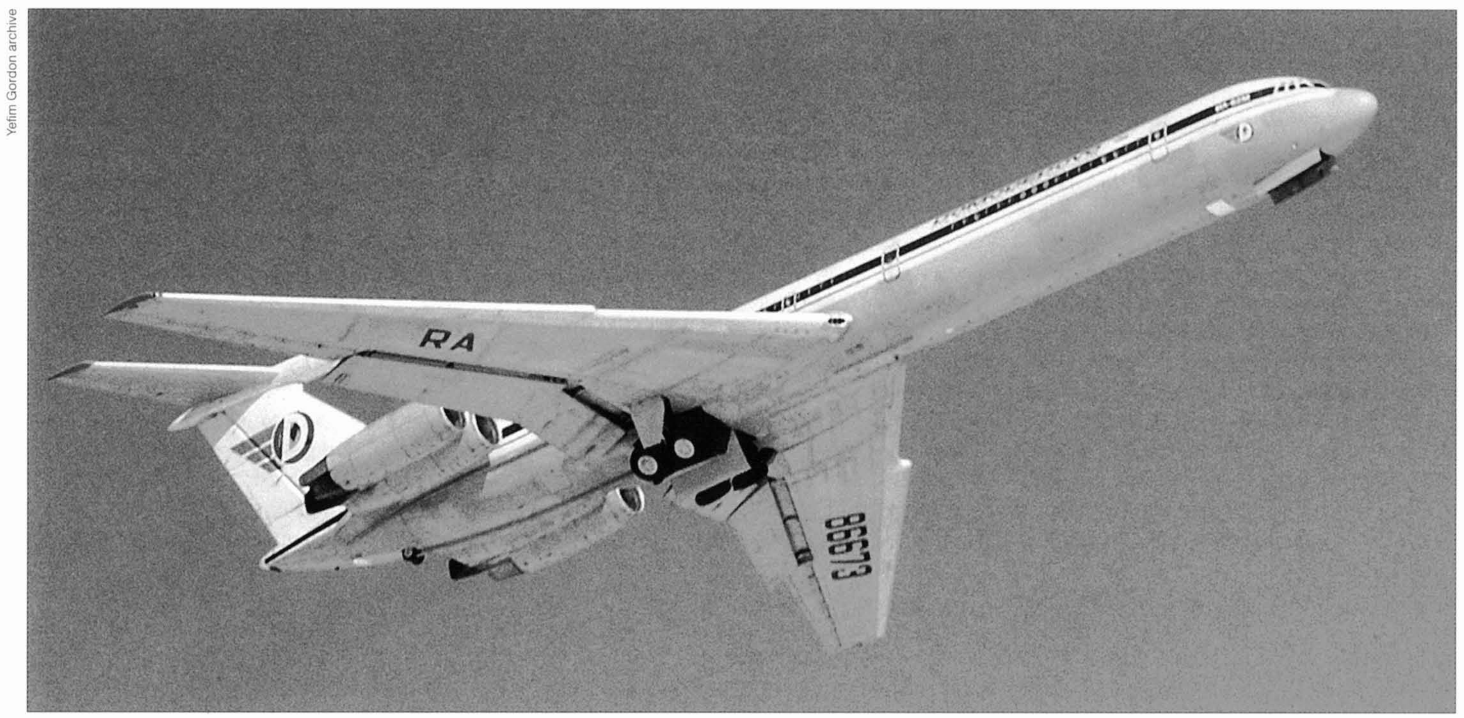
Dmitriy Komissarov

Above: IL-62M -JBI (ex-OK-JBI, c/n 2932748) languished at Moscow/Vnukovo-1 from 4th November 1997 to February 2001 (the picture was taken on 29th May 2000). It now serves with Vim Airlines as RA-86597.

Specifications of the IL-62 and IL-62M

	IL-62 (early production)	IL-62	IL-62M
Engines	NK-8-2	NK-8-4	D-30KU
Take-off thrust, kgp (lbst)	4 x 9,500 (20,950)	4 x 10,500 (23,152)	4 x 11,000 (24,255)
Wing span	43.3 m (142 ft 0¾ in)	43.3 m (142 ft 0¾ in)	n.a.
Length overall	53.12 m (174 ft 3⅜ in)	53.12 m (174 ft 3⅜ in)	n.a.
Wing area, m² (sq ft)	282.2 *(3,037.8)	279.55 (3,009.3)	279.55 (3,009.3)
Take-off weight, kg (lb)	157,500 (347,287)	161,600 (356,328.)	165,000 (363,825)
Maximum payload, kg (lb)	23,000 (50,715)	23,000 (50,715)	23,000 (50,715)
Cruising speed, km/h (mph)	850-900 (528-559)	850 (528)	870 (541)
Range, km (miles):			
with max fuel			
and 10-tonne (22,045-lb) payload	9,200 (5,717)	10,000 (6,215)	11,050 (6,868)
with max payload	6,700 (4,172)	7,550 (4,692)	8,300 (5,158) †
Cruising altitude, m (ft)	9,500-12,000 (31,170-39,370)	9,500-12,000 (31,170-39,370)	9,500-12,000 (31,170-39,370)
Take-off run, m (ft)	1,800 (5,905)	1,930 (6,332)	2,250 (7,382)
Landing run, m (ft)	1,000 (3,280)	1,000 (3,280)	-
Landing speed, km/h (mph)	220-240 (137-149)	265 (165)	265 (165)

* including the wing leading-edge extensions † without fuel reserves



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This Domodedovo Civil Aviation Production Association IL-62M, RA-86673, seen here retracting the undercarriage as it climbs away from its home base, is the former CCCP-86673 No.2 (c/n 3154416). The IL-62 is an elegant airliner.

IL-76 airlifter

The IL-76, no doubt, occupies a special place among the aircraft created by the Ilyushin OKB. This was the Soviet Union's first jet transport to be designed from scratch, the first to enter production – and the most prolific, with some 930 built to date and production still continuing. Originally dismissed as a 'C-141 StarLifter clone', it has earned world recognition as a competent freighter. It has made its mark in such famous conflicts as Afghanistan and Chechnya and found a stable niche on the civil air transport market.

The IL-76 owed its inception to the need for an An-12 replacement which inevitably arose at a certain juncture, despite a very good service record of Antonov's cargo plane. The VVS needed a jet transport with equally good field performance (including rough-field capability) and the ability to operate independently from ground support equipment but with much higher speed and a bigger payload. So did Aeroflot, which had to haul heavy equipment to oil and gas fields in Siberia and goods coming in via seaports in the Far East. Enter the Ilyushin IL-76.

A matter of paramount importance for the OKB was the choice of the correct design philosophy. Experience showed that a dedicated freighter, not a warmed-over airliner, was the correct approach. The specific operational requirement (SOR) for such an aircraft was drawn up on 28th June 1966; on 27th November 1967 the Soviet Council of Ministers issued a directive tasking the Ilyushin OKB with developing a four-jet freighter designated IL-76.

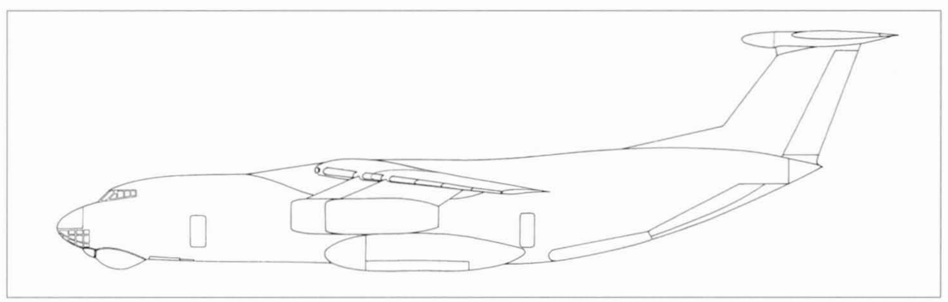
This was the first Ilyushin aircraft to be designed under someone other than the bureau's founder. Sergey V. Ilyushin's health had been failing and he retired in 1970; thus his deputy, Ghenrikh V. Novozhilov, was the IL-76's chief project engineer. Soon after Novozhilov had succeeded Ilyushin as General Designer, Radiy Petrovich Papkovskiy was appointed IL-76 project chief in 1975.

The freighter's design specifications were perhaps the most stringent of the time. The IL-76 had to carry a 40-ton (88,18-lb) payload over 5,000 km (3,100 miles) – twice the payload and range of the An-12 – in less than six hours with lower operating costs. It had to be capable of using dirt or snow strips with a bearing strength of no more than 6 kg/cm² (85.35 lb/sq in) and operating away from maintenance bases for up to 90 days at ambient temperatures ranging from -70°C to +45°C (-94/+113°F). Take-off and landing run at normal take-off and landing weight was not to exceed 900 m (2,952 ft) and 500 m (1,640 ft) respectively.

The general arrangement was identical to that of the Lockheed L-300-50A (C-141 Starlifter), with a circular-section fuselage, shoulder-mounted anhedral wings with moderate sweepback, a T-tail and four turbofans in separate underwing nacelles. Since the Starlifter had been around for quite some time by then (the YC-141A prototype, 61-2775, had entered flight test on 17th December 1963), Western aviation experts inevitably started comparing the IL-76 to the C-141 as soon as they had seen it – with the customary allegations that 'the Soviets had once again copied a Western design'. Such accusations were often unfounded, since the similarity in many cases was purely superficial (the IL-62 vs VC-10 is a case in point). As for the apparent similarity between the C-141 and the IL-76, engineers in different countries facing the same problem will often come to similar solutions.

The elegant airlifter we know today was presaged by two rather ungainly preliminary development projects. Version 1 had an An-12-style nose with a glazed navigator's station and a chin-mounted ground mapping radar, albeit in a much longer and deeper radome. The aft fuselage originally *did* resemble the C-141 with its rather plump contours, and the fin had a prominent fillet.

The cargo door design, however, was rather different. The IL-76 featured three cargo door segments; the narrow outer segments opened outwards and the wide centre segment upwards to lie flat against the cargo cabin roof, propped up by the flat rear pressure bulkhead which swung backwards and up. This arrangement developed jointly with TsAGI minimised drag when the doors were opened in flight for paradropping. By comparison, the C-141 had clamshell cargo doors which protruded far beyond the fuselage contour when opened, causing considerable drag.



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The first project configuration of the IL-76.

The landing gear originally was also quite similar to that of the C-141, with a forward-retracting twin-wheel nose unit and four-wheel main bogies retracting upwards into lateral fairings. The latter were quite large because the IL-76 had fat low-pressure tires for rough-field capability; still, having the main units retract inwards would have necessitated raising the cargo cabin floor, which was undesirable. This was important because the IL-76 sat fairly high over the ground (unlike the C-141 which was designed for paved runways and had a rather short undercarriage, with a small ground clearance). The extra drag of the bulky main gear fairings could be compensated by fitting more powerful engines.

The IL-76 was powered by four 12,000-kgp (26,455-lbst) Solov'yov D-30KP two-shaft turbofans – an uprated version of the 11,000-kgp (24,250-lbst) D-30KU developed for the IL-62M long-haul airliner by Pavel A. Solov'yov's OKB-19 in Perm', now called the *Aviadvigatel'* (= Aero Engine) Production Association.

Despite the similar designation, the D-30KU/KP has only some 15% commonality (in the core) with the 6,800-kgp (14,990-lbst) D-30 developed for the Tu-134 *Crusty* short/medium-haul airliner. Bypass ratio is 2.42 compared to 1.0 for the D-30; besides, the D-30KP has a clamshell thrust reverser (optional on the D-30KU) whereas the D-30 Srs II/Srs III has a cascade thrust reverser and the D-30 Srs I has none. Incidentally, the higher bypass ratio resulted in a much more agreeable sound.

As a point of interest, the original project evolved into a 250-seat airliner in January 1967. This project incorporated several unusual features. Firstly, it was one of the very few high-wing airliners to have a double-deck fuselage (the only other known aircraft of the kind is a 720-seat monster based on the An-22 which likewise never got off the drawing board). The top floor seated 184 in six- or seven-abreast economy-class seating and the lower floor 66 three-abreast. Secondly, the lower floor was divided lengthwise into a port side baggage compartment and a starboard-side passenger cabin (!). For the first time in Soviet practice the baggage was containerised. Thirdly, the aircraft had three integral airstairs – two on the lower deck on the port side and a third under the aft fuselage in similar manner to the Boeing 727 or Douglas DC-9, with direct access to the upper deck.

A massive redesign was made in February 1967. The avionics suite was updated to include the ***Koo**pol* ground mapping radar (cupola – or rather, in this context, parachute canopy, implying use of the system for pinpoint paradropping) in a chin fairing and the *Gro**za*** (Thunderstorm) weather radar ahead of the navigator's station. Consequently the nose was made more elongated to incorporate the weather radar. The Koopol radar was a product of LNPO Leninets, one of the Soviet Union's major avionics designers.

The rear fuselage became even fatter, making the fin look disproportionately small and giving the fuselage a banana-like shape. (The upswept rear fuselage could easily have earned the IL-76 the nickname 'flying banana', had it flown in this guise.) The aircraft had one port side crew entry door near the nose gear and two doors for paradropping aft of the main gear fairings, as on the Lockheed C-130 Hercules.

The wings were swept back 25° at quarter-chord, with 4° incidence, an aspect ratio of 8, a taper of 3 and an area of 240 m² (2,582 sq ft). Thickness-to-chord ratio was 13% at root and 10% at the tips. Structurally the wings were made up of five sections, the centre section being integral with the fuselage and located outside the circular-section pressure cabin so as not to infringe on cargo bay height. The wings had a straight leading edge and a sharply kinked trailing edge where the inner and outer wing panels were joined.

The inboard engine pylons were attached to the inner wings and the outboard pylons to the outer wings which had sharply raked detachable tip fairings. The integral wing tanks held 86,360 litres (18,999 Imp gal) or 66,95 tons (147,600 lb) of fuel.

The IL-76 featured two-section triple-slotted flaps (for the first time on a transport aircraft; in contrast, the C-141 has double-slotted flaps) and five-section leading-edge slats to ensure good field performance. The flaps were set at 20° for take-off and 40° for landing; the slats were deflected 20° and terminated some way short of the fuselage. Roll control was by means of large ailerons occupying the outer one-third of the trailing edge and four-section spoilers/lift dumpers.

The main landing gear was thoroughly redesigned, featuring two independent twin-wheel levered-suspension units in tandem on each side. These were spaced so as to increase the landing gear footprint, reducing ground pressure, and enable the aircraft to land on three main units without taking damage if one failed to extend. Tyre size was 1,450 x 580 mm (57 x 22.8 in) on the mainwheels and 1,140 x 350 mm (44.8 x 13.7 in) on the nosewheels.

The freight hold was 24.0 m (78 ft 8⅞ in) long, including a 4-m (13 ft 1½ in) loading ramp, 3.4 m (11 ft 1⅞ in) wide and 3.45 m (11 ft 3⅞ in) high, with a volume of 330 m³ (11,654 cu ft) and a floor area of 67 m² (720 sq ft).

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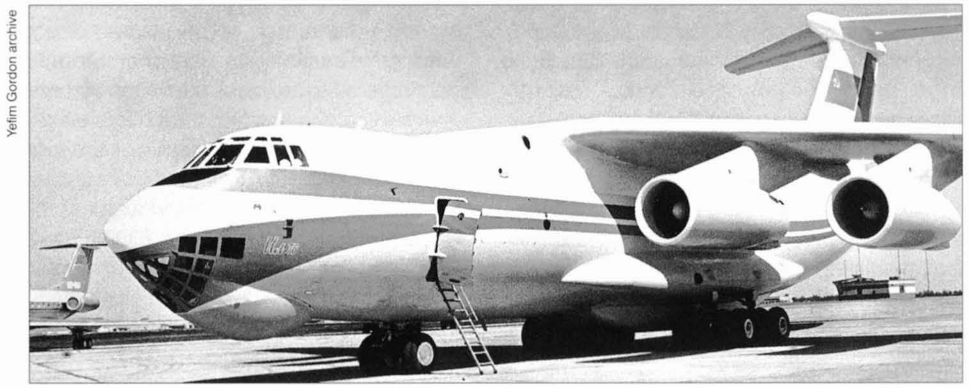

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The first prototype IL-76, CCCP-86712 (c/n 01-01), on the apron at Moscow/Vnukovo-2 airport during a display for the Soviet government. Note the spike on the No.1 engine intake bullet fairing, probably associated with test equipment.

The dimensions were selected so as to match the dimensions of a standard Soviet Model 02-T boxcar. The hold was equipped with a gantry crane which ran on rails running the full length of the roof and beyond the pressure bulkhead; this enabled it to lift loads right off a truck or trailer standing near the cargo ramp. In fully lowered position the ramp was inclined 14°, allowing wheeled and tracked vehicles to be loaded under their own power; there were two winches for loading trailers and the like. The freight hold floor was located 2 m (6 ft 6¾ in) above ground level.

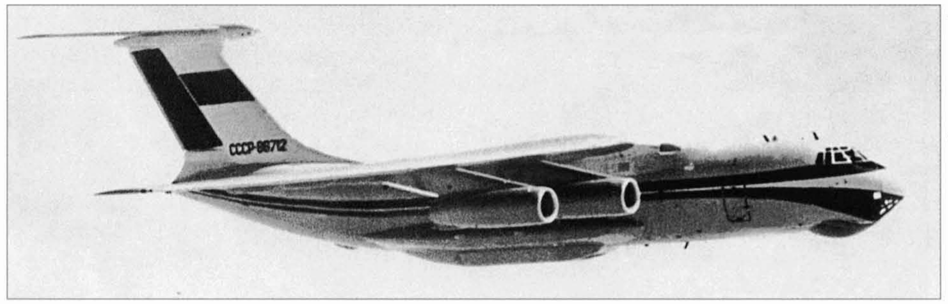
The flightdeck located on the 'second floor' was accessed by a ladder from freight hold floor level while the navigator entered his compartment via a door to the right of this ladder; a toilet was located symmetrically to port. A compartment for eight passengers was envisaged aft of the flightdeck. The stillborn double-deck airliner project of 1967 inspired the engineers to provide a removable top deck in the freight hold for carrying troops. In an emergency the crew and troopers evacuated via three dorsal emergency exits (two ahead of the wings and one aft). The crew consisted of two pilots, a navigator, a flight engineer, a radio operator, two equipment operators and two technicians.

The port main gear sponson housed a TA-6A auxiliary power unit for self-contained engine starting, equipment operation and air conditioning; it had a lateral air intake and a dorsal exhaust. DC batteries and a reconnaissance camera (primarily for checking paradropping accuracy) were located symmetrically in the starboard sponson. Unusually, four 500-kg (1,102-lb) bombs could be carried in closed bays at the rear of the main gear sponsons; this was a requirement of the VVS which insisted that a transport aircraft *absolutely* had to be capable of dropping bombs in case of need. There was as yet no defensive armament.

As of February 1967 the IL-76 had an overall length of 46.85 m (153 ft 8½ in), a fuselage length of 42.5 m (139 ft 5¼ in), a fuselage diameter of 4.8 m (15 ft 9 in), a wingspan of 43.8 m (143 ft 8½ in) and a height on ground of 13.7 m (44 ft 11⅜ in).

More major changes came by 1969, however. The fuselage nose ahead of the flightdeck glazing was shortened and recontoured to reduce the blind spot ahead of the aircraft during taxying. Both radomes were reshaped and optically flat glass panels were introduced in the navigator's glazing to improve visibility. The radome of the ground mapping radar protruded below the lower fuselage contour to give the radar 360° coverage, so a special towbar with a characteristic kink in the middle had to be designed for the IL-76 to avoid damaging the radome.

The aft fuselage was now much slimmer with virtually no adverse effect on freight hold volume, which was 321 m³ (11,336 cu ft). The paratroop doors aft of the wings



Ilyushin Aviation Complex

An air-to-air shot of CCCP-86712. Note the cupola-like antenna aft of the flightdeck.

were deleted, but a second entry door was added symmetrically to starboard; the doors could be opened hydraulically 90° in flight for paradropping. The dorsal escape hatches in the freight hold were replaced by four emergency exits – two at main deck level ahead of the wings and two at upper deck level aft of the wings; the flightdeck roof hatch was retained for quick access to the dinghy in the event of ditching. A flightdeck escape hatch with a hydraulically-powered door doubling as a slipstream deflector was added on the port side of the nose just aft of the navigator's station for bailing out in an emergency.

The wings underwent a major redesign. Flap settings were now 15° or 30° for take-off and 43° for landing; the slats were deployed 14° (at 15° flap) or 25°. There were four-section airbrakes inboard and four-section spoilers/lift dumpers outboard, and the ailerons were now divided into two sections. Trailing-edge sweep was increased slightly on the inner wings, making the kink less pronounced, and the wingtips were reshaped, being parallel to the fuselage axis. All four engine pylons were now attached to the inner wings and more sharply swept; full-span slats were provided (with cutouts in the two inboard sections to stop them from striking the pylons when fully deployed), and the air conditioning intakes were moved to the wing/fuselage fairing.

The vertical tail was reshaped, closely resembling that of the IL-62, with a much smaller root fillet and a smooth transition from fin to fuselage. The rudder (which, unlike the IL-62, was a one-piece structure) now stopped short of the rear fuselage, thus allowing a tail gunner's station to be incorporated – the aircraft was designed primarily as a military transport, after all.

The landing gear was totally reworked once again, as the engineers decided to improve soft-field performance while 'cleaning up' the bulky main gear sponsons. The answer to the first problem was to increase the landing gear footprint once again. The result was an unconventional arrangement with five independent units, each having four wheels on a single axle (that is, two pairs each side of the oleo). The nose unit retracted forward and the four main units inward to lie in two shallow ventral fairings. During retraction the mainwheel axles rotated around the oleos by means of simple mechanical links so that the wheels stowed vertically with the axles parallel to the fuselage axis; a similar arrangement had been used earlier on the Hawker Siddeley HS.121 Trident airliner. Tyre size was 1,300 x 480 mm (51.2 x 18.9 in) on the mainwheels and 1,100 x 330 mm (43.3 x 13.0 in) on the nosewheels. Tyre pressure could be adjusted in flight between 2.5-5 bars (36-73 psi) to suit different types of runways (paved or unpaved).

The landing gear fulcrums and actuators were enclosed by separate lateral fairings of quasi-triangular section which also housed the APU and single-point pressure refuelling panel (port) and DC batteries (starboard). The APU intake now featured an inward-opening door to prevent windmilling during cruise and the exhaust was located laterally.

Besides being much cleaner aerodynamically, the new arrangement gave a much wider landing gear track (and hence footprint). It also allowed the main gear doors to close when the gear was down, preventing mud, water and slush from entering the wheel wells, which was important when operating from unprepared runways. Previously the mainwheels had been semi-recessed in the sponsons *à la* An-22 when the gear was down, rendering this impossible.

Changes were made to the cargo handling equipment. The overhead gantry crane was replaced initially by two and then by four separate cargo hoists capable of lifting 2,500 kg (5,511 lb) each. These could move 5.65 m (18 ft 6½ in) beyond the cargo ramp for straight-in loading from a truck bed, since the cargo door centre segment fitted nicely between the tracks on which they moved.

The titanium floor incorporated fold-away roller conveyors for container handling and recessed cargo tiedown points, with removable roller conveyors on the cargo ramp; palletised or containerised cargo could be easily secured by chains and quick-release shackles. Importantly, the cargo tie-down lugs were installed permanently, unlike the An-12 where they were normally stowed in the hold and had to be screwed into place as required – with all the resulting inconveniences.

The cargo ramp incorporated a U-shaped tail bumper and four manually-retractable vehicle loading ramps. It could be used to lift loads weighing up to 2,500 kg (5,510 lb), though some sources quoted an exorbitant figure of 30 tons (66,140 lb); this was a useful feature when loading vehicles which have difficulty negotiating the angle between the ramp and freight hold floor (especially tracked vehicles). In this case a hydraulically-powered support stowed in the cargo ramp would be extended to stop the aircraft from falling over on its tail.

The external dimensions and proportions were also rather different. The aircraft was 46.5 m (152 ft 6¾ in) long, 14.7 m (48 ft 2¾ in) high, had a 50.5-m (165 ft 8¼ in) wingspan and a 300 m^2 (3,228 sq ft) wing area. The well-knit aircraft had an air of rugged dependability about it – a real transporter which will get your cargo there no matter what.

Empty weight was 86 tons (189,590 lb) and maximum take-off weight 157 tons (346,120 lb). On paved runways the IL-76 had a payload of 40 tons (88,180 lb) decreasing to 33 tons (72,750 lb) on grass, dirt or snow strips. The aircraft was designed for a service life of 30,000 hours, 10,000 cycles and 20 years.

Ilyushin engineers had gone to great lengths to increase reliability and survivability. For example, the control runs, electric wiring and hydraulic lines were routed along both sides of the fuselage to prevent them from being totally disabled by a single hit. Also, much attention had been paid to flightdeck and navigator's station design to make the aircraft 'user-friendly'. Completely new flight instrumentation, navigation and targeting systems were developed to make sure the aircraft would fulfil its mission anytime.

The advanced development project was reviewed by the mock-up review commission from 12th to 31st May 1969 and received the go-ahead. Construction of a full-scale wooden mock-up commenced in December at the OKB's experimental plant, MMZ No.240, at Moscow-Khodynka. To save space the mock-up featured only the complete fuselage and vertical tail, part of the horizontal tail and part of an inner wing with the inboard engine. Yet the cargo doors and ramp were fully operational and the freight hold floor was stressed so that real vehicles could be driven inside to demonstrate the freighter's capacity without falling through. The mock-up review commission was quite satisfied with the aircraft, pointing out only minor deficiencies. It was green light for the IL-76.

After some minor changes based on the commission's findings the design was frozen in December and MMZ No.240 began construction of the first prototype registered CCCP-86712 (c/n 01-01, that is, Batch 1, first aircraft in the batch). Work on the aircraft's systems proceeded in parallel; an 'iron bird' for control system testing was built at plant No.240 along with hydraulics, electrics and landing gear test rigs. The IL-76 had a duplex control system with irreversible hydraulic boosters and a backup manual mode – an unusual feature for an aircraft of this size.

Being virtually hand-crafted, the first prototype of any aircraft takes a lot of time to build. Given the large size of the IL-76, the job took more than a year to accomplish. CCCP-86712 was rolled out in early March 1971. The aircraft had a white upper fuselage and fin, light grey undersurfaces, wings, stabilisers and engine nacelles, a blue rudder and a blue/white/blue cheat line fanning out towards the front.

Ground systems tests went well and the OKB was eager to begin flight tests. These would be held at the then top-secret flight test centre in Zhukovskiy. Usually prototypes built by the experimental shops of various OKBs were trucked to LII from Moscow in dismantled condition. However, plant No.240 had the advantage of being located at Khodynka with its 1,700-m (5,580-ft) runway, so the OKB leaders decided the aircraft should be flown to Zhukovskiy. (Unlike the case of the IL-62 prototype, the good field performance of the IL-76 allowed it to be flown out of Khodynka.)

The opening lines of a feature in the *Pravda* (Truth) daily newspaper on 19th May 1971 describing the type's first flight read as follows: *'It was March. The country was getting ready for the Congress of the Communist Party.'* Sure enough, timing major achievements to coincide with CPSU congresses was the order of the day in the Cold War-era Soviet Union. But there was an even more important reason for rushing the first flight: the 29th Paris Aerospace Salon at Le Bourget was due to take place on 25th May – 6th June 1971 and the Ilyushin OKB wanted to unveil the aircraft there.

An MAP council convened to decide whether the aircraft was ready to fly. The situation was undoubtedly complicated; an aircraft grossing more than a hundred tons (220,460 lb) was due to take off in a heavily populated area some 6 km (3.72 miles) from the Kremlin! Besides, the Igor' V. Kurchatov Nuclear Physics Research Institute with its reactors was directly in the flight path; the consequences of the aircraft crashing there could be disastrous.

Yet, eventually the council gave the go-ahead. On 25th March 1971, with nearly every Ilyushin OKB employee watching anxiously, the IL-76 prototype became airborne after a take-off run of only 685 m (2,250 ft) and made for Zhukovskiy. The aircraft was captained by OKB-240 chief test pilot Eduard I. Kuznetsov, Hero of the Soviet Union.

The first flight lasted little more than an hour. Immediately upon arrival CCCP-86712 commenced the preliminary performance and handling test programme aimed at obtaining clearance to display the aircraft in Paris. Kuznetsov said the aircraft behaved almost flawlessly from the start; hence Stage 1 of the manufacturer's flight tests was rather brief and on 17th May the prototype was demonstrated to Soviet government and Communist Party leaders at Moscow/Vnukovo-2 (the government VIP terminal).

Ilyushin Aviation Complex

An excellent shot of the first prototype as it banks away from the camera ship, revealing its undersurfaces. The two prototypes were built in unarmed commercial configuration.

Novosti Press Agency

Above: The second prototype IL-76 *sans suffixe*, CCCP-86711 (c/n 01-03), retracts the landing gear as it takes off from Kubinka AB in 1973. Note the Le Bourget exhibit code 455.

ITAR-TASS

An Ikarus 250 coach is backed into IL-76 CCCP-86712 at Surgut-Pobedit airport during service trials with Aeroflot in 1975. A special extended ramp had to be built up for this purpose due to the vehicle's limited drive-on/drive-off angles. Note that the aircraft is equipped with a spin recovery parachute for low-speed tests and wears photo calibration markings on the fuselage and has black wing/tail unit leading edges.

A week later, on 25th May the IL-76 arrived at Le Bourget wearing the exhibit code 829 – and stole the show. Western observers named it the most notable débutante of the show. Until 1988, when the MiG-29 *Fulcrum-A* fighter and MiG-29UB *Fulcrum-B* combat trainer appeared at Farnborough International, Soviet participation in airshows had been strictly civilian, displaying the Soviet Union's peaceful intentions for the world to see. Yet this time the message was patently clear: the Soviets were rapidly catching up with the West in strategic airlift capability.

When questioned about possible military uses of the jet Ilyushin OKB representatives at the show steadfastly maintained that the IL-76 was 'a purely commercial aircraft'. This elicited ironic smiles from Western journalists; the unspoken comment was 'who are you trying to fool?' Indeed, what would a purely commercial transport need both a weather radar and a ground mapping radar for? The high-flotation landing gear, too, spoke for itself.

Western specialists were not allowed inside the aircraft at Le Bourget '71 and OKB reps were pretty close-mouthed about technical details even by pre-*glasnost* standards. This led the West to conclude the IL-76 had few novel features, even if it doubtlessly represented a major advance in Soviet aircraft technology and a colossal boost to the Soviet Air Force's logistical support capability. (As for novel features, the sceptics were wrong; the aircraft incorporated more than 180 inventions of varying degrees of importance for which more than 30 international patents were issued.). After its Paris debut the IL-76 was allocated the NATO reporting name *Candid*.

After coming back from Le Bourget CCCP-86712 resumed flight tests, with black and white phototheodolite calibration markings applied to the fuselage in several places. For low-speed/high-alpha handling trials the tailcone was modified to house a large anti-spin parachute canister with a hemispherical cover. The first prototype was also used for electromagnetic compatibility (EMC) tests.

Initial trials of the IL-76 in the military transport role commenced on 3rd February 1972 when parachutists were dropped for the first time; the aircraft was flown by Eduard I. Kuznetsov. The parachutists jumped through the cargo door, entry doors (which opened hydraulically 90° for protection against the slipstream) and the flightdeck escape hatch. To use the latter, you had to kneel and then dive head first down a 2-m (6.5-ft) sloping chute. (This arrangement was never used operationally, as crews seemed to prefer crashing with the aircraft; besides, it was unusable in the event of hydraulics failure).

On 19th February the aircraft successfully performed the first drop of a 5-ton (11,020-lb) load. The first jumps went well and on 3rd April CCCP-86712 was used for a full-scale paradrop test, disgorging a full load of 115 paratroopers near Zhukovskiy. MAP and Parachute Design Institute personnel and cadets from the Ryazan' Airborne Troops Command Academy took part in these trials. Again, Kuznetsov flew the aircraft on both occasions. After this, MAP and the Air Force requested that a detachable upper deck be designed for the IL-76 to permit carriage of an additional 100 soldiers in troop transport configuration. The aircraft was also evaluated in the casualty evacuation (CASEVAC) role.

On 17th August 1972 Eduard I. Kuznetsov was promoted to Merited Test Pilot (an official grade reflecting pilot expertise and experience) in recognition of his service – including the IL-76 test programme.

Meanwhile, a static test airframe (c/n 01-02) was built at MMZ No.240, followed by the second prototype, CCCP-86711 (c/n 01-03). This made its maiden flight from Moscow-Khodynka on 25th February 1973 – again captained by E. I. Kuznetsov, with P. M. Fomin as engineer in charge.

The aircraft featured some minor improvements which found their way into production. For example, the landing lights were moved forward and down to a position immediately aft of the navigator's glazing.

The upper anti-collision light, which was mounted atop the fin *à la* IL-62 on CCCP-86712, was relocated to the wing centre section, and the IFF aerials ahead of the flightdeck glazing and under the tailcone were enclosed by fairings.

Unlike the first prototype, CCCP-86711 had an electro-pulse de-icing system on the wings (used later on the IL-86 *Camber* widebody airliner). However, the traditional hot air de-icing system was found to be adequate and fitted to all subsequent *Candids*. The tail unit was electrically de-iced.

The second prototype was used primarily for powerplant, avionics and cargo handling equipment testing. Later it was loaned to GK NII VVS, operating from Chkalovskaya airbase east of Moscow where the institute's transport aircraft section was, and still is, located (the main facility is in Akhtoobinsk in southern Russia). CCCP-86711 was also used in 'Operation Cold Soak' in Yakutsk and Petropavlovsk-Kamchatskiy to evaluate the type's suitability for operation in harsh climates.

Wearing the exhibit code 455, the second prototype was displayed at the 30th Paris Aerospace Salon from 26th May to 3rd June 1973. This time Western observers were allowed to examine the interior. Once again OKB representatives stuck rigidly to the official 'purely commercial freighter' story; General Designer Ghenrikh V. Novozhilov stated to *Air International* that the principal purpose of the IL-76 was supply of remote regions of the Soviet Union having no railway facilities. Other Soviet delegates at Le Bourget, however, tacitly admitted that the *Candid* had military uses as well.

The career of CCCP-86711 ended when the aircraft struck an airport building while taxying and was damaged beyond repair. It became a ground instructional airframe at RKIIGA (***Rizh****skiy krasnozna**myon**nyy institoot inzhe**ne**rov grazh**dahn**skoy avi**ah**tsiï* – Riga Red Banner Institute of Civil Aviation Engineers) and sat at Riga-Spilve airport. Sadly, this aircraft was scrapped in mid-1997 along with the other Aeroflot aircraft preserved there.

Meanwhile, MAP aircraft factory No.84 in the Uzbek capital of Tashkent was gearing up for full-scale production of the IL-76. The factory had been established in Khimki, a suburb of Moscow, evacuating to Tashkent in 1941 when German troops came dangerously close to the city. Over the years, factory No.84 had built the PS-84/Lisunov Li-2, IL-14, An-8, An-12 and An-22. Now it is called TAPO (*Tash**kent**skoye aviatsi**on**noye proiz**vod**stvennoye obyedi**nen**iye* – Tashkent Aircraft Production Association named after Valeriy Pavlovich Chkalov). The transition to a new aircraft was difficult but the Tashkent plant had some prior experience with Ilyushin aircraft and this surely helped.

The first production IL-76 built in Tashkent, CCCP-76500 (c/n 033401016, f/n 0104) took off on 8th May 1973. Like the two prototypes, it was built in unarmed commercial configuration and was the first *Candid* to wear full 1973-standard Aeroflot colours. It differed from the prototypes in having a shorter rear portion of the wing/fuselage fairing – a feature introduced on all subsequent aircraft. (Note: The c/ns of production aircraft are deciphered as follows: the first two or three digits denote the year of manufacture (03 = 1973, 000 = 1980, 100 = 1990 etc), 34 is a code for the factory and the rest is the 'famous last five' meaning nothing at all. Hence the additional fuselage numbers denoting the batch number and the number of the aircraft in the batch (ten per batch).

CCCP-76500 was also flown to Ilyushin's flight test facility at LII and used for cargo handling equipment tests and stability trials during personnel and cargo drops. The aircraft was subsequently retained by the OKB which used it for various test and development work.

From 24th to 29th August 1973 the second prototype completed a special test programme to check the type's suitability for operation from unpaved strips. The aircraft was captained by G. N. Volokhov, with P. M. Fomin as engineer in charge of the tests. The take-off and landing proper caused no problems; the 20-wheel landing gear did an excellent job – the C-141 would be no match for this 'centipede'. However, as the IL-76 took off it kicked up a terrific dust cloud which obscured the strip completely; the pilots had to circle for some 20 minutes, waiting for the dust to settle before a landing could be attempted.

From 10th to 16th September 1973 the CCCP-86711 was displayed at an airshow in Iruma, Japan. Again the aircraft was captained by G. N. Volokhov, with P. M. Fomin as engineer in charge.

The IL-76 turned out to be an extremely versatile aircraft, with numerous more or less specialised versions appearing as the Ilyushin OKB strove to improve the design. Known versions of the aircraft are detailed below.

Ilyushin Aviation Complex

An air-to-air shot of the first production IL-76, CCCP-76500 (c/n 03341016, f/n 0104). The aircraft was again built in commercial configuration.

Yefim Gordon archive

Above: A typical Soviet Air Force IL-76 *sans suffixe* in military configuration. Although the rear tail gunner's station is not visible in this view, the characteristic teardrop-shaped ECM fairings on the forward and rear fuselage sides identify the aircraft clearly as a *Candid-B*.

IL-76 military transport

Rolled out in October 1973, the second production aircraft, CCCP-76501 (c/n 033401019, f/n 0105), was the prototype of the armed military transport version. Curiously, this initially had no separate designation to distinguish it from the commercial version, both variants being known simply as 'IL-76'. Later, when new versions designated by suffix letters appeared, the initial production versions became known unofficially as *il-**sem**'desyat-**shest**' 'bez **book**vy'* – 'IL-76 with no [suffix] letter', or *sans suffixe*. When the West became aware of its existence, the military version was code-named *Candid-B*, the original commercial version becoming the *Candid-A*.

The most obvious recognition feature of the *Candid-B* is, of course, the tail gunner's station and UKU-9K-502-1 powered turret with two Gryazev/Shipoonov GSh-23 double-barrelled 23-mm (.90 calibre) cannons. (UKU = *oonifi**tsee**rovannaya kormo**va**ya oosta**nov**ka* – standardised tail [gun] installation. The same turret and gun ranging radar are fitted to the Tu-22M1/M2 *Backfire-B* and Tu-95MS *Bear-H* bombers). A PRS-4 Krypton gun ranging radar is fitted at the base of the rudder above the gunner's glazing; its boxy radome gave rise to the NATO codename *Box Tail*. (It has to be said that the efficacy of the armament is questionable, to say the least, as a modern fighter will more than likely fire an air-to-air missile without coming within range of the cannons!)

The gunner's station, which technologically is the rearmost section of the fuselage, is a separate pressurised compartment accessed from the freight hold via a door in the rear pressure bulkhead. The gunner walks up the centre cargo door segment and enters his compartment via a door in the forward wall. An escape door is provided on the starboard side, opening hydraulically to protect the gunner against the slipstream in the event of bailing out.

Yefim Gordon archive

CCCP-76505 (c/n 073411331, f/n 0903) delivered to the Tyumen' CAD/2nd Tyumen' UAD/435th Flight on 25th November 1977 was one of the few delivered to Aeroflot as commercial IL-76s *sans suffixe*.

In addition to shooting down unwary fighters, the cannons could be used against ground targets (!) and for passive electronic countermeasures (ECM) and infra-red countermeasures (IRCM). Quite simply, they could fire rounds filled with metal-coated fibreglass strips and rounds filled with a termite mixture along with ordinary ammunition. Exploding behind the aircraft, these special rounds would decoy radar-guided and IR-homing missiles respectively.

The other major difference from the commercial version is the provision of paradropping equipment; hence the crew includes a paradrop equipment operator. The freight hold is equipped with 'traffic lights', an illuminated 'Ready – Go!' sign and a siren to tell the paratroopers it was time to hit the silk.

A double row of quickly removable seats, back to back, can be installed down the centre of the freight hold to complement the standard collapsible seats along the walls. An upper deck can be suspended from the ceiling if troops are to be airlifted; the aircraft can carry 140 fully-equipped troops or 125 paratroopers. Oxygen and rescue equipment is provided for the troops. The freight hold can be decompressed for paradropping, leaving the flightdeck pressurised.

The starboard main gear fairing houses an inert gas generator burning jet fuel to pressurise the fuel tanks and reduce the hazard of explosion if hit by enemy fire. This can be identified by a small circular air intake at the front.

CCCP-76501 underwent armament trials at GK NII VVS's main facility in Akhtoobinsk in southern Russia (near Saratov on the Volga river); the possibility of dropping bombs via the cargo ramp was investigated among other things. After retirement the aircraft became a ground instructional airframe at the Kirovograd Civil Aviation Flying School (KVLUGA – *Kirovo**grahd**skoye **vys**sheye **lyot**noye oo**chil**ischche grazh**dahn**skoy avi**ah**tsii*) in the Ukraine, now the Ukraine State Flight Academy.

The first 'really production' *Candid-B*, CCCP-86600 (c/n 033401022, f/n 0106), was delivered to the Soviet Air Force in late 1973. The first fifty or so production aircraft were all military examples; it was not until December 1976 that commercial IL-76s *sans suffixe* started rolling off the line! Production aircraft had an active ECM system with six teardrop antenna fairings (four on the forward fuselage sides and two on the aft fuselage) to give 360° coverage and two small rounded fairings on the navigator's glazing. However, the system was removed from many Soviet AF *Candid-Bs* in service.

One of the port side forward ECM fairings incorporated a wing/air intake inspection light. This had been tested on CCCP-86712, appearing on civil and military IL-76s alike in late 1977, and was subsequently retrofitted to all previously built aircraft.

Export *Candid-Bs* (IL-76s *sans suffixe*, IL-76Ms and IL-76MDs) are unusual in lacking the inert gas generator in the starboard main gear fairing; also, no ECM gear is fitted.

IL-76MGA commercial transport

This designation has been quoted for the initial commercial IL-76 *sans suffixe*; MGA stands for *Mini**ster**stvo grazh**dahn**skoy avi**ah**tsii* – Ministry of Civil Aviation. However, the source says only two were built, which cannot be true – twelve civil IL-76s *sans suffixe* are known, including the two prototypes.

IL-76M military transport

As early as 6th March 1970 the OKB started work on a high gross weight version of the IL-76. The wing torsion box was reinforced and an additional integral tank was provided in the wing centre section, increasing the fuel load to 80 tons (176,390 lb); 84,840 kg/ 187,040 lb has also been quoted. Fuel capacity was increased to 104,171 litres (22,917 Imp gal). Maximum payload when operating from paved runways was increased to 48 tons (105,820 lb) and MTOW to 170 tons (374,780 lb). The upgraded military airlifter was designated IL-76M (*modifi**tsee**rovannyy* – modified).

The only external recognition features were appropriate nose titles and dark blue panels on the engine pylon trailing edges, wing undersurface (near the outer engines) and the port main gear fairing aft of the APU exhaust. These blue areas were introduced for cosmetic reasons. The D-30KP is a rather smoky engine; when reverse thrust was repeatedly applied on landing the wings and pylons soon became black with soot, making the aircraft look rather untidy. Washing it every now and again would be too troublesome, so neat dark panels were introduced to make the dirt less conspicuous. Previously built aircraft were soon painted up in this fashion. (On civil *Candids* the 'anti-soot panels' may be black, dark red or green.)

The IL-76M prototype, CCCP-86728 (c/n 073410322, f/n 0901) made its first flight at Tashkent-Vostochnyy airfield on 24th March 1978 with captain Stanislav G. Bliznyuk and first officer V. I. Sviridov at the controls. Deliveries to the Soviet Air Force and foreign customers began that year.

RART

Above: YI-AKO (c/n 093416506, f/n 1307), an Iraqi Air Force IL-76M. The aircraft wears Iraqi Airways titles but has a grey/white military colour scheme left over from the days when it wore full military markings and the serial 2803. It was later returned to the USSR, becoming CCCP-76490.

IL-76T commercial transport

Predictably, the improvements introduced on the IL-76M (more fuel and higher payload/gross weight) were soon incorporated in the civil version; development was likewise initiated on 6th March 1970. The resulting aircraft was designated IL-76T (***trahns**portnyy* – [civil] transport, used attributively) and superseded the commercial IL-76 *sans suffixe*. IL-76T project review by an MAP and MGA commission was completed on 6th June 1973.

Captained by V. I. Sviridov, the IL-76T prototype (CCCP-76511, c/n 083414444, f/n 1201) made its maiden flight in Tashkent on 4th November 1978. On 8th February 1979 it was unveiled at a civil aircraft display at Moscow-Sheremet'yevo, courtesy of GosNII GA). After retirement the aircraft was relegated to KIIGA (***Kiy**evskiy insti**toot** inzhe**n**erov grazh**dahn**skoy avi**ah**tsii* – the Kiev Institute of Civil Aviation Engineers) as a ground instructional airframe at Kiev-Zhulyany.

IL-76MD military transport

The IL-76M evolved into a high gross weight/extended-range version designated IL-76MD (*modifi**tsee**rovannyy, **dahl**'niy* – modified, long-range). It features D-30KP Srs 2 turbofans uprated to 12,500 kgp (27,560 lbst) and maintaining full power up to ISA +23°C (73°F) (some sources indicate +27°C /80°F) instead of ISA +15°C (59°F). These are interchangeable with the D-30KP Srs 1; pairs of Srs 1 engines can be replaced by Srs 2 engines or vice versa during repairs, providing they are installed symmetrically (Nos 1 and 4 or Nos 2 and 3).

Internal fuel capacity is increased to 90 tons (198,410 lb) or 117,192 litres (25,782 Imp gal) by enlarging the wing tanks; this extends range by 400 km (248 miles) when operating from paved runways or by 300 km (186 miles) when operating from dirt strips. MTOW is 190 tons (418,870 lb) on paved runways or 157.5 tons (347,220 lb) on dirt strips. Maximum payload is increased to 50 tons (110,230 lb). The wings and landing gear are reinforced to cater for the higher gross weight.

Yefim Gordon archive

A BMD-1 paradroppable armoured fighting vehicle is ready for loading into IL-76M CCCP-86826 (c/n 093419588, f/n 1507); the wheels on the P-7 pallet serve for ground handling only. The tail gunner's station and the UKU-9K-502-I tail turret with two twin-barrel cannons are clearly visible.

RART

Above: The commercial IL-76 *sans suffixe* was quickly superseded by the IL-76T and the previously built aircraft were updated accordingly. Here, the aircraft shown on page 280 is seen at Moscow-Domodedovo as IL-76T RA-76505 in the colours of Abakan-Avia in the late 1990s.

Outwardly the IL-76MD is almost identical to the M, except for the nose titles; also, the outer landing lights originally built into flap track fairings at approximately mid-span are moved outboard. being located under the wingtips.

As with the IL-76M, not all MDs have ECM gear. Late-production aircraft built from approximately 1987 onwards have the SRO-2M Khrom (Chromium; NATO *Odd Rods*) IFF transponder with its trademark triple aerials of unequal length replaced by an SRO-1P *Parol'* (Password), aka *izdeliye* 62-01, transponder with equally characteristic triangular blade aerials.

Two small pylons can be fitted under each outer wing for carrying bombs up to 500 kg (1,102 lb) or paradroppable radio beacons used during major airborne operations. (The requirement about bombs mentioned above was still there, but on the real aircraft the main gear fairings had no room for bombs.) The pylons were rarely used, though occasionally during exercises the IL-76MDs would drop psy-war bombs stuffed with age-old propaganda leaflets.

There are some minor changes to the equipment, including the electrical system and the cargo door controls. On the IL-76MD the outer door segments open first and close last; on the IL-76M it is the centre door segment which opens first and closes last.

The prototype IL-76MD with the out-of-sequence registration CCCP-86871 (c/n 0013434002, f/n 2601) made its maiden flight from Tashkent on 6th March 1981 with a crew captained by Vyacheslav S. Belousov. This aircraft was retained by the Ilyushin OKB and used a lot for various development work. The 'MD replaced the earlier model on the production line from Batch 26 onwards.

An important feature introduced on the IL-76MD in late 1984 is provision for IRCM equipment for protection against heat-seeking missiles – an improvement based on Afghan war experience. Initially, 96-round APP-50 chaff/flare dispensers (APP = *avto**maht** pas**siv**nykh po**mekh*** – 'automatic passive ECM/IRCM device') firing 50-mm (1.96-in) magnesium IRCM flares were faired into the aft portions of the ventral mainwheel fairings; these protruded slightly and were canted outwards to cover a wider area. Tests continued from 28th December 1984 to 26th March 1985. The test aircraft was flown by crews captained by Yuriy P. Klishin and V. Kotov; M. S. Gol'dman and M. A. Alekseyev were the engineers in charge of the test programme.

In 1987 the built-in version was supplanted or supplemented by podded 96- or 192-round dispensers strapped on to the rear fuselage sides just aft of the main gear fairings; this arrangement was tested on IL-76MD CCCP-76650 (c/n 0053462865, f/n 4707). The strap-on dispensers create more drag than the built-in version, of course, but can be fitted and removed as required; the electrical connectors for the APP-50s are protected by small elongated covers when the dispensers are not fitted. Not all IL-76MDs received these updates. After the Afghan War the built-in flare packs were removed on many aircraft as surplus and their locations faired over with sheet metal.

Surprisingly, the IL-76 also has a VIP/staff transport role. The Tashkent plant's own design bureau developed the KShM-76 module (*ko**mahnd**no-shtab**noy** mo**dool'*** – command and headquarters module) from the UAK-20 cargo container (*ooniver**sahl'**nyy aviat**sion**nyy kon**tey**ner* – multi-purpose, that is, air/sea/land container), up to three of which can be carried by the IL-76. The KShM-76 incorporates air conditioning and power systems, oxygen and communications equipment and affords comfortable working conditions for up to eight VIPs. The module measures 6.098 x 3.2 x 2.758 m (20 ft 0 in x 10 ft 6 in x 9 ft 0½ in) and weighs 4,000 kg (8,818 lb) fully equipped. The KShM-76 module was unveiled at the MAKS-95 airshow in Zhukovskiy.

RART

Above: YI-ALT (c/n 0033448393, f/n 3509) was one of several 'true' IL-76MDs operated by the Iraqi Air Force in full Iraqi Airways livery. Unlike many IrAF IL-76s, this aircraft was not returned to the Soviet Union.

Yefim Gordon

Ukrainian Air Force IL-76MD UR-76413 (c/n 1013407215, f/n 8104) taxies out under threatening skies at RAF Fairford in 1999. This aircraft is unusual in having ECM antennas built into the wingtips.

IL-76TD commercial transport

This is the civil equivalent of the IL-76MD incorporating the same improvements (TD = ***trahns**portnyy, **dahl'**niy* – [civil] transport, long-range). The prototype, CCCP-76464 (c/n 0023437090, f/n 2803), took to the air on 5th May 1982; it was delivered to Aeroflot in 1985 after comprehensive testing. All commercial *Candids* built from 1982 onwards were IL-76TDs. One aircraft, CCCP-76481 (c/n 0053460795, f/n 4509), was used for lengthy test and development work by GosNII GA.

Apart from cargo, the IL-76TD can carry three passenger modules, likewise based on the UAK-20 container. Each module accommodates up to 32 passengers four-abreast and features a galley and a toilet.

IL-76T 'Falsie', IL-76TD 'Falsie'

Curiously, some *Candid-Bs* obviously built as military aircraft with a tail gunner's station wear misleading inscriptions – 'IL-76T' or 'IL-76TD'. The authors call such pretenders IL-76T 'Falsie' and IL-76TD 'Falsie' respectively (by analogy with the so-called Boeing C-135A 'Falsie', which was really a KC-135A tanker with the 'flying boom' removed).

Moreover, many IL-76T/TD 'Falsies' have been demilitarised – that is, the tail turret and gun ranging radar are removed and faired over (and sometimes even the gunner's station windows are overpainted) so as to dispel any doubts about their civilian status; a practice also followed by ex-Air Force An-8s and An-12s. Two slightly different styles of the dished fairing replacing the tail turret have been noted.

Until the mid-1990s, such aircraft were all ex-Iraqi IL-76M/MDs (mostly operated by MAP). Thus a possible explanation is that, since Iraqi *Candids* were operated by the Iraqi Air Force, they were considered military equipment for legal purposes. Since Russian trade legislation prohibits purchase of military equipment by civilian organisations, the aircraft had to be redesignated to pass them off as the commercial version. Lately, however, a number of IL-76MDs (notably those operated by the Belorussian airline TransAVIAexport, a subsidiary of the Belorussian Air Force) have been demilitarised and partially repainted, wearing 'IL-76TD' titles. While these are not ex-Iraqi aircraft, they were 'renamed' for much the same reason, since they operate on civil cargo flights and a 'military' designation would be somewhat inappropriate.

Dmitriy Komissarov

Above: The IL-76TD was the main commercial version. Here, UK-76449 *Shenyang* (c/n 1023403258, f/n 7705) leased by Moscow-based East Line from Uzbekistan Airways is seen at Moscow-Domodedovo in November 1998 in the green-tailed version of the full livery. It carries the Russian flag, despite the Uzbek registration.

IL-76M 'Falsie', IL-76MD 'Falsie'

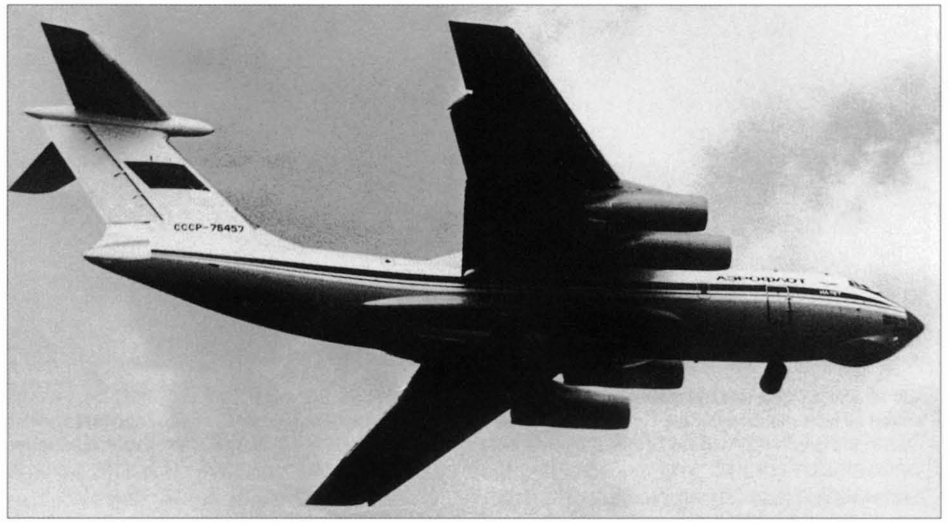
Conversely, some aircraft in apparently commercial configuration with pointed tailcone are marked 'IL-76M' or 'IL-76MD'! These are *not* conversions of 'true' *Candid-Bs*; they were actually built with no tail gunner's station and nobody knows the reason why. Another peculiarity of such aircraft is

Dmitriy Komissarov

Above: IL-76TD 'Falsie' RA-76659 of Atruvera (c/n 0053463908, f/n 4807) is unloaded at Moscow/Vnukovo-1 on 29th May 2000. The tail gunner's station is clearly visible.

Ilyushin Aviation Complex

CCCP-76822 (c/n 0093499982, f/n 7506) operated by the Ilyushin OKB was one of several examples built as IL-76MD 'Falsies'.



Viktor Drushlyakov

The still unpainted new 'commercial' tailcone and the built-in flare packs in the main gear fairings identify IL-76T CCCP-76457 (c/n 093421621, f/n 1606) as a converted IL-76M (ex-CCCP-86925 No.1).

that the inert gas generator air intake in the starboard main gear fairing is usually faired over with a neat elliptical plate but still visible upon close inspection.

Only four IL-76M 'Falsies' are known (CCCP-86879, CCCP-86891, YK-ATC and YK-ATD). On the other hand, IL-76MD 'Falsies' are plenty (CCCP 76753, CCCP-76803 and CCCP-76822 are just three of the 40-odd known examples).

Some *Candids* known to be IL-76MD 'Falsies' have now been repainted as IL-76TDs! Known aircraft are RA-76388 (ex-CCCP-78851), RA-76389 (ex-CCCP-78852), RA-76822 and RA-76845.

IL-76MD to IL-76TD (IL-76M to IL-76T) conversions

Obviously someone decided that simply demilitarising an ex-Air Force *Candid-B* is not enough. In early 1998 the Russian Air Force's aircraft overhaul plant No.123 in Staraya Roossa began converting IL-76MDs to IL-76TD standard, mostly for civil operators. This involves removing the gunner's pressurised compartment (section F4) at the manufacturing joint (fuselage frame 90) and bolting on a 'scratchbuilt' commercial tailcone. Strictly speaking, this 'plastic surgery' makes sense, as it cuts empty weight by some 1,000 kg (2,200 lb).

Known aircraft converted in this fashion are RA-76591, RA-76666, EW-76710 through EW-76712, EW-76734, EW-76735, EW-76737, CCCP-76781, RA-76790, RA-76823, RA-78792, EW-78799, EW-78801 and EW-78828. A curious feature of these aircraft is the inert gas generator air intake crudely faired over by a protruding plate with three prominent stiffening ribs. This is the giveaway that you are looking at a converted 'true' IL-76MD, not an IL-76MD 'Falsie' renamed to match the exterior. Sometimes the conversion is even more obvious because nobody took the trouble to repaint the whole aircraft; the freshly-painted tailcone and pieces of the cheatline where the 'IL-76TD' titles are make a sharp contrast with the weathered finish on the rest of the airframe! Moreover, quasi-civilian IL-76TD CCCP-76781 (ex-IL-76MD CCCP-86927, c/n 0023439133, f/n 2904) operated by the Russian Federal Border Guards retains the built-in APP-50 chaff/flare dispensers, which indicates it has seen action in Afghanistan when it was an 'MD.

Quasi-civilian IL-76T CCCP-76457 (c/n 093421621, f/n 1606), another FBG aircraft, is a converted and reregistered IL-76M (ex-CCCP-86925 No.1) – the only known conversion among Ms. Like many Aeroflot and quasi-Aeroflot aircraft, IL-76s had two registration styles (in a rounded or an angular type face), and CCCP-76457 showed obvious signs of being reregistered: the CCCP-prefix was in rounded type characteristic of early *Candid-Bs* while the digits were in the later angular type! This aircraft is unique among IL-76Ts in having built-in APP-50 chaff/flare dispensers – a leftover from its days as an IL-76M and an Afghan War veteran. IL-76T CCCP-86926 (later reregistered CCCP-76780; c/n 0013430901, f/n 2306) may be a similar conversion.

IL-76MD *Skal'pel'-MT (izdeliye* 576) mobile hospital

From the outset the *Candid-B* could be used for CASEVAC duties. To this end several tiers of stretchers were fixed to uprights in the freight hold; the medevac kit could be installed or removed in about two hours. In reality, however, it was rarely used.

Yet what the army needed was a real flying hospital where surgery could be performed en route – this could make the difference between life and death or a whole man and a cripple. Thus on 6th January 1976 MAP issued a directive ordering the development of a 'flying operating room' based on the IL-76; this received the appropriate codename *Skal'pel'* (this name was also used for the 'medical' An-26M *Skal'pel'*).

The CASEVAC issue suddenly became very acute when the Soviet Union got involved in the Afghan war; getting critically wounded personnel to 'Unionside' hospitals quickly was a real problem. Still, development was rather slow. The prototype of the IL-76MD Skal'pel'-MT flying hospital, CCCP-86906 (c/n 0023436064, f/n 2706), did not make its first flight until 23rd July 1983. Two IL-76s have been equipped to this standard; the other aircraft is reportedly c/n 1023412408 (f/n 8602, identity unknown).

By mid-1988 CCCP-86906 received special markings in accordance with its role – a large red cross on the tail instead of the Soviet flag and smaller red crosses on the wing undersurface. The aircraft is equipped with four APP-50 chaff/flare dispensers.

The freight hold of the Skal'pel'-MT houses three modified cargo containers. One of them is an operating room, another is equipped as an intensive care unit and the third is the 'ready room' accommodating stretchers with patients. The containers can be unloaded and function as a stationary hospital in case of need; to this end a gasoline-driven generator is provided to power the equipment.

In addition to the Afghan war, the IL-76MD Skal'pel'-MT prototype was called upon to treat victims of the Armenian earthquake in December 1988 and a major train crash near the Bashkirian capital of Ufa in 1990. Duly reregistered RA-86906, it was later used operationally in the First Chechen War of 1994-96, making daily flights to Mozdok and Beslan to pick up casualties.

There have been other tasks, however; for example, the aircraft airlifted the Russian Army hospital at Beelitz to Russia as Russian troops pulled out of Germany. In February 1996 RA-86906 participated in the SAREX'96 army rescue service exercise staged in Canada by the US, Canadian and Russian armed forces. The aircraft operates from Chkalovskaya airbase.

IL-76TD-S mobile hospital

Building on operational experience with the IL-76MD Skal'pel'-MT, the Ilyushin OKB developed a similar mobile hospital for civilian needs in 1991. This is known as the IL-76TD-S (*sani**tar**nyy* – medical), aka the Aibolit airliftable medical complex (Doctor Aibolit – lit. 'ouch, it hurts!' – is a Russian children's book character).

Additionally, the IL-76 can deliver the Ganimed paradroppable containerised medical unit developed by the Aviaspetstrans consortium (or, to be precise, the Myasishchev OKB which was part of it) and the Parachute Systems Design Institute (*Naoochno-is**sled**ovatel'skiy insti**toot** para-**shoo**tostro**yen**iya*). The Ganimed container was dropped by the first production *Candid-A* (CCCP-76500) and an unidentified IL-76MD during trials.

IL-76PS (IL-76MDPS) maritime SAR aircraft

Development of a maritime search and rescue version of the *Candid* was initiated by a ruling of the VPK on 28th June 1972. Designated IL-76PS (*pois**kov**o-spa**sah**tel'nyy* – SAR, used attributively), the aircraft was to supplant the lifeboat-carrying An-12PS and Tu-16S *Fre**gaht*** (Frigate) *Badger-A* operated by the Soviet Naval Air Arm. Some sources claim that, apart from rescuing the occupants of ships in distress or downed aircraft, the SAR version was also to support the Soviet manned space programme, rescuing space crews in the unlikely event of a splashdown somewhere in the ocean.

The IL-76PS carried a 7.4-ton (16,310-lb) *Ga**ga**ra* (Loon) lifeboat which could be paradropped with a crew of three on sighting people in distress. The Gagara had a 500-km (270-nm) range and a top speed of 7 kts. Maximum seating capacity was 20 rescuees; additionally, the lifeboat could tow a PSN-25/30 inflatable rescue raft (*plot spa**sah**tel'nyy nadoov**noy***) with another 25 or 30 persons.

The lifeboat was loaded on a purpose-built P-211 pallet and equipped with an MKS-350-10 parachute system comprising ten 350-m² (3,763-sq ft) parachutes (MKS = *mnogo**koo**pol'naya [para**shoot**naya] sis-**te**ma* – multi-canopy [parachute] system). Paradropping was possible at 600-1,500 m (1,970-4,920 ft) and 350-370 km/h (217230 mph kts) in conditions up to sea state five (that is, waves up to 2.9 m/9½ ft high) and winds up to 20 m/sec (40 kts). After being extracted by an 8-m² (86-sq ft) VPS-8 drogue parachute (VPS = *vytyazh**na**ya para**shoot**naya sis**te**ma* – parachute extraction system) the pallet fell away and a 100-m (330-ft) guiderope was deployed to orientate the lifeboat downwind before splashdown. After that, the lifeboat would be guided by UHF remote control or by making a pass over it in the direction of the target. The Gagara was a product of the Leningrad-based Redan (Planing step; pronounced *re**dahn***) SKB (SKB = *spetsi**ahl'**noye kon-**strook**torskoye byu**ro*** – 'special' (that is, specialised) design bureau), while the parachute system was developed by the Parachute Systems Design Institute.

Apart from the lifeboat, it was possible to drop KAS-150 rescue capsules (*kon**tey**ner ava**reey**no-spa**sah**tel'nyy*) and teams of up to 40 rescue workers. The navigation system was upgraded, permitting the aircraft to reach the designated target area with an error margin of 2% of the distance covered; the system could use emergency radio transmitters or beacons to home in on the stricken ship or aircraft.

Development began in 1981. With the advent of the longer-range IL-76MD this was selected as the carrier aircraft and the SAR version was redesignated IL-76MDPS. Captained by Yuriy V. Mazonov, the prototype, IL-76MD 'Falsie' CCCP-76621 (c/n 0043456695, f/n 4304), took off at Tashkent on 12th (some sources say 18th) December 1984. At least one more *Candid* – IL-76TD CCCP-76471 (c/n 0033446345, f/n 3407) – participated in the trials programme, performing test drops of the lifeboat.

Trials continued until 1987 at three locations – Pskov Lake, the Minghechauri Reservoir (Azerbaijan) and the Black Sea (near Feodosiya on the Crimea Peninsula), with Aleksandr M. Tyuryumin (HSU) as project test pilot. Seventeen test drops of the Gagara were made, including two with people on board. The results were good and the IL-76MDPS was recommended for production. The aircraft had a maximum operating radius of 4,700 km (2,540 nm). An IL-76MDPS standing on ready alert could be prepared for a sortie in just 35 minutes.

Sadly, the programme was terminated on 7th April 1989 – incidentally, the very day when the Soviet nuclear submarine SNS *Komsomolets* (K-278) sank in the Barents Sea with the tragic loss of nearly all hands. The reason was the AVMF's wish to keep the An-12PS and Tu-16S SAR aircraft, both of which were developed 'in-house', and eliminate competition. IL-76MDPS CCCP-76621 was relegated to the Kirovograd flying school as a ground instructional airframe with a mere 300 hours' total time on it.

IL-76P (IL-76TP, IL-76TDP, IL-76MDP) firebomber

Nikolay Dmitriyevich Talikov, who succeeded Radiy P. Papkovskiy as IL-76 project chief, led the development of a waterbomber version of the *Candid* for fighting forest fires. This was an important task, considering the vast expanse of taiga in the eastern regions of the country. Until then, however,

Sergey and Dmitriy Komissarov archive

Seen here at Pushkin in the early 1990s, Il-76MD Skal'pel'-MT CCCP-86906 (c/n 0023436034, f/n 2706) displays the appropriate Red Cross markings and the double set of APP-50 chaff/flare dispensers.

Yefim Gordon

IL-76TDP RA-76845 *Mikhail Vodop'yanov* (c/n 1043420696, f/n 9304) operated by EMERCOM of Russia stages a water-bombing demonstration at one of the Moscow airshows.

the capabilities of Soviet firefighting aircraft had been rather modest. The An-2PP (***pro**tivopo**zhar**nyy* – firefighting, used attributively), a modified An-2V *Colt* floatplane (CCCP-01262), did not progress beyond the prototype stage; nor did a landplane water-bomber version of the An-2. The most common solutions were the use of helicopters with externally slung water tanks (the Mil' Mi-6PZh and Mi-6PZh-2 *Hook* with internal tanks was an exception) or simply paradropping fire-fighters into the area.

The Antonov OKB continued working in this direction, developing the An-24LP (***les**opo**zhar**nyy* = for fighting forest fires), a simple adaptation of the An-24RV twin-turboprop airliner which seeded cumulus clouds with rainmaking chemicals. This was followed by the An-26P and An-32P Firekiller, both of which had large water tanks scabbed on to the fuselage sides. The Beriyev OKB in Taganrog on the Black Sea joined the race in the late 1980s, modifying the Be-12 Chaika ASW amphibian into the Be-12P firebomber; five Russian Navy aircraft have been converted to this configuration to date.

Talikov's idea, however, was that any IL-76 should be quickly adaptable for firefighting duties without modifications (unlike the Antonov and Beriyev competitors) and revert to standard configuration just as easily. The obvious solution was a modular system with tanks in the freight hold so that the water was emptied over the cargo ramp. The waterbomber was designated IL-76P (*pozharnyy* – firefighting). Since any *Candid* can be configured for the firefighting role, the designations IL-76TP, IL-76TDP and IL-76MDP are also used occasionally.

The firefighting system was developed in late 1988 and a prototype was built early in the following year. The module consisted of two tubular tanks running almost the full length of the freight hold. The tanks were mounted on a frame sloping gently towards the rear to facilitate emptying; wheels and a towbar could be attached to this frame for ground handling. Each tank had a hinged door at the rear, with two counterweights sticking up like horns, and a trough to guide the water over the cargo ramp; the door lock was controlled by a system of linkages. The front end featured standard fire hose connectors for filling up and overflow hoses; supply and overflow hoses went through the entry doors, so that any excess water ended up outside the aircraft.

On the original VAP-1 experimental firefighting module (*vylivnoy aviatsionnyy pri**bor*** – 'aircraft-mounted liquid-pouring device'), sections of ordinary steel pipes (the kind used in gas pipelines) were utilised to save time. Thus the tanks were 1.22 m (4 ft 0 in) in diameter and 14 m (45 ft 11⅛ in) long, with walls 14 mm (½ in) thick. Their total capacity was 32 m³ (1,130 cu ft) or 32,000 litres (7,040 Imp gal) of water, which equals 32 tons (70,550 lb).

Water drops are made at an altitude of 80-200 m (260-630 ft), depending on the terrain and visibility conditions; the tank doors are opened by two equipment operators as commanded by the navigator over the intercom. The two tanks can be emptied simultaneously to extinguish a small fire or consecutively to keep a major fire from spreading; in the latter case a special OS-5 fire retardant may be used instead of water. In a simultaneous dump at 80 m and 280 km/h (174 mph) the IL-76P can drop a full load of water in four or five seconds, dousing an area measuring 400 x 100 m (1,310 x 330 ft) with up to 5 litres/m²; in a consecutive drop at the same speed and altitude the area covered is 600 x 80 m (1,970 x 260 ft).

Special piloting techniques are used for firefighting sorties. For example, in hilly or mountainous terrain the aircraft approaches the fire from the higher ground so as not to collide with the mountains after entering the smoke pall. Immediately after dropping the water the aircraft climbs away sharply. If there is a really big fire, several aircraft can work consecutively.

On 22nd September 1989 IL-76MD CCCP-76623 (c/n 0053457705, f/n 4307) operated by the Ilyushin OKB made the first flight with the VAP-1 module, thus becoming the prototype IL-76P; the aircraft was captained by Igor' R. Zakirov. The 'company-owned' IL-76MD prototype, CCCP-86871, joined the programme later when a second module was built. The two aircraft were tested operationally in the summer of 1990, successfully fighting forest fires in the Krasnoyarsk Region. This involved working over all kinds of terrain, from plains to hills 600 m (1,968 ft) high to mountains up to 2,500 m (8,200 ft) high)

Originally the cargo doors were fully opened for water drops. However, it was quickly discovered that vortices around the doors would cause water to enter the aft fuselage and soak the equipment located there, causing short circuits. Ilyushin engineers tried covering the equipment with tarpaulins but these were torn to shreds by the turbulent airstream as soon as the cargo doors were opened. The problem was cured by simply lowering the cargo ramp, leaving the doors closed.

The IL-76P was publicly unveiled on 2nd August 1990 when CCCP-76623 performed 'live' at Moscow-Tushino, taking part in a show on occasion of the semi-official Airborne Forces Day.

More action came in the spring of 1992. On 9th April fire broke out at an ammunition dump near Yerevan, causing violent explosions. Splinters and unexploded ammunition rained down on the nearby village of Balaovit, forcing an urgent evacuation. The Armenian authorities immediately contacted the Ilyushin OKB, and shortly after 11.00am the company-owned IL-76MD 'Falsie' CCCP-76822 (c/n 0093499982, f/n 7506) equipped with a full VAP-1 module took off for Yerevan. The crew was captained by Igor' R. Zakirov. Meanwhile, pumps and an adequate supply of water were set up at Yerevan-Zvartnots airport.

Because of the hilly terrain and lightning masts on the ammunition dump, a local navigator who knew the place well had to be picked up. Before the day was out the aircraft had made three sorties, extinguishing the fire almost completely; after that, ground forces could move in. Next day Zakirov flew two more sorties for good measure to make sure the dump wouldn't flare up again.

A month later, on 15th May another ammunition dump blew up near Vladivostok in the Far East. This time IL-76MDP CCCP-76623 captained by the Ilyushin OKB's CTP, Distinguished test pilot Stanislav G. Bliznyuk (HSU) was dispatched to take care of the fire. The mission was far more complicated. The dump was surrounded by mountains up to 400 m (1,312 ft) high, which meant it could only be approached from one direction, with a power station chimney straight ahead. On 16th May the IL-76MDP flew seven sorties before noon; several times violent explosions forced a go-around because there was serious danger of being hit by fragments and 'shot down'. Nikolay D. Talikov commanded the mission on both occasions.

The OKB had been trying to win government support for the IL-76P for a long time, and it was these successful firefighting operations that tipped the scales. In July 1992 the Russian government allocated 31 billion roubles to the State Committee for Emergency Situations (since transformed to Ministry of Emergency Situations, or EMERCOM) for the outfitting of five IL-76s as firebombers.

As if to reinforce the point, peat fires broke out around Moscow during the following month, and IL-76Ps were called upon to fight fires near Noginsk and Shatoora in the Moscow Region.

On 28th January 1993 CCCP-76623 commenced a new round of trials with the new VAP-2 firefighting module. This was larger than the original model, holding 42,000 litres (9,240 Imp gal) or 42 tons (92,590 lb) of water. Tank diameter was increased to 2.2 m (7 ft 2⅝ in), but the tanks were made of aluminium alloy and the walls were just 5 mm (0.19 in) thick. The module could be loaded and secured by four men in 1.5-2 hours, using the aircraft's cargo handling equipment, and then filled up from a hydrant or a fire engine in just 15 minutes.

Once again Igor' R. Zakirov flew the aircraft and M. N. Weinshtein was in charge of the test programme. The VAP-2 completed its trials successfully and a batch of five units was built for EMERCOM. Meanwhile, the Ilyushin OKB is contemplating an even bigger firefighting module holding 60,000 litres (13,200 Imp gal)!

The IL-76P had its share of airshow performances. On 18th August 1991 – one day before the failed hard-line Communist coup d'état which brought an end to the Soviet Union's existence – CCCP-76623 was to demonstrate firefighting at the Aviation Day flypast in Zhukovskiy (the LII airfield was still off limits to the general public then). Unfortunately, the demonstration fizzled when the tower did not authorise the crew to dump the water; when the go-ahead was finally given some 20 minutes later the spectators had given up and gone home.

On 15th August next year, however, the same aircraft performed excellently at MosAeroShow '92 in Zhukovskiy, Russia's first major airshow (11-16th August), extinguishing a very smoky pile of burning car tyres. Some all-too-eager photographers who were standing a bit too close (way outside the public area) got drenched! They had it coming.

On 19th May 1993 two IL-76TPs took part in a civil defence exercise near Noginsk in the Moscow region which was part of the Central, East and South-East European Conference on Civil Defence and Disaster Control. In July of that year a company demonstrator, IL-76TDP RA-76835 (c/n 1013408244, f/n 8201), was displayed at the Paris Airshow with the exhibit code 306 and an 'Ilyushin Aviation Complex' badge on the nose. This aircraft remained firmly in the static park at the MAKS-93 airshow in Zhukovskiy (31st August/5th September 1993), with nothing to identify it as a firebomber, leaving the visitors guessing why it was there. Yet the visitors were treated to a display of firefighting technique by Veteran Airlines IL-76MDP UR-76698 (c/n 0063471123, f/n 5401) on 2nd September. This time there were no more burning tyres – the organisers of the show were clearly becoming environmentally conscious!

In September of that year an IL-76P participated in a UN exercise in Austria. On 19th-22nd October IL-76MDP UR-76727 (c/n 0073475268, f/n 5707) loaned from Veteran Airlines and captained by Stanislav G. Bliznyuk helped extinguish a forest fire near Yalta, the famous Black Sea resort. At the same time (20th-22nd October) the Ilyushin OKB's IL-76MD 'Falsie' RA-76822 captained by I. I. Goodkov fulfilled an identical mission near Kislovodsk, a Caucasian resort.

More show performances came in 1994 when IL-76TDP RA-76389 (c/n 1013407212, f/n 8103) with 'Water Bomber' titles took part in Farnborough International '94. This aircraft belonged to the Russian Veteran Airline, a sister company of the Ukrainian carrier of the same name. On 8th and 9th September 1994 Veteran Airline IL-76T 'Falsie' RA-86846 (c/n 0003426765, f/n 2002) equipped with a VAP-2 module and flown by Igor' R. Zakirov was demonstrated to US Forestry Department officials at the Larkhill artillery range near RAF Boscombe Down. On 21st-26th March 1995 the same aircraft participated in Airshow Down Under '95 in Melbourne.

RART

IL-78MDK RA-78770 (c/n 0083487617, f/n 6605) basks in the sun at Chkalovskaya AB, awaiting its next training sortie.

In November 1995 the IL-76P and the VAP-2 module received a gold medal at the 44th Bruxelles-Eureka World Inventions, Research and Innovation Salon. Finally, EMERCOM IL-76TDP RA-76845 (c/n 1043420696, f/n 9304) took part in the flying display at the MAKS-97 airshow (19-24th August 1997).

IL-76K zero-G trainer

Zero-gravity training is an important part of an astronaut's training programme. Part of it is done in a special water tank with a submerged spacecraft mock-up. However, nothing beats real weightlessness, so space centres the world over use specially-modified aircraft for astronaut training. Such aircraft follow a parabolic trajectory, and on the way down zero gravity is experienced for 20-30 seconds.

The Soviet cosmonaut group in ***Zvyozd**nyy Goro**dok*** (Star Town) near Chkalovskaya AB used three Tu-104AKs (specially-modified ex-Aeroflot Tu-104A *Camel* airliners) coded '46 Red' (ex-CCCP-42390, c/n 8350705), '47 Red' (ex-CCCP-42389, c/n 8350704) and '48 Red' (c/n 86601302). the K means [*dlya podgo**tov**ki*] *kosmo**nahv**tov* – for cosmonaut training. However, these were narrowbody aircraft offering rather limited room for floating around or staging experiments in zero-G conditions.

Therefore, as early as 24th July 1972 the CofM Presidium's Commission on Defence Industry Matters ruled that the Ilyushin OKB should develop a zero-G trainer version of the IL-76. This was designated IL-76K (once again, K means [*dlya podgo**tov**ki*] *kosmo**nahv**tov* – for cosmonaut training).

The prototype, CCCP-86638 (c/n 073409232, f/n 0608), was converted from a standard military IL-76 *sans suffixe* at the Tashkent aircraft factory and made its first flight on 2nd August 1981 at the hands of Ilyushin OKB CTP Stanislav G. Bliznyuk. Outwardly the IL-76K was identical to the very first *Candid* (CCCP-86712) at a late stage of the manufacturer's flight tests: the gunner's station had been eliminated and replaced by a rounded 'solid' tailcone housing an anti-spin parachute. The airframe was suitably reinforced, however, to cope with the augmented loads experienced during the special flight profile which are equivalent to several normal flights.

The freight hold had handrails running along the walls at three levels and additional lighting. The capacious innards of the *Candid* (235 m³/8,299 cu ft) sure gave the cosmonauts plenty of room to bounce. Besides, it could accommodate mock-ups of spacecraft modules and test rigs weighing up to 6 tons (13,230 lb) for verifying the operation of the spacecraft's systems in zero-G conditions; these were easily loaded through the standard cargo doors. Test equipment was installed at the front of the hold to monitor and record the results of the experiment and the cosmonauts' life signs.

The parabolic trajectory flown by the IL-76K was developed by project engineer V. V. Smirnov. This trajectory was normally repeated 10-25 times during a sortie. The techniques used on the IL-76K included the use of 'free-floating' test rigs which were disengaged from the aircraft's structure once weightlessness began to make the experiment more realistic.

Two more military IL-76s *sans suffixe*, CCCP-86723 (c/n 073410279, f/n 0710) and CCCP-86729 (c/n 073410300, f/n 0805), were converted to IL-76K standard. Interestingly, both were sold in 1996-97 (to Express Joint-Stock Company and IDF Iron Dragonfly respectively), becoming RA-76372 and RA-76430 respectively, and featured in airline fleet lists as IL-76Ts (which they are *not* – they cannot even be considered IL-76T 'Falsies'!). The prototype (CCCP-86638) ended its days as a ground instructional airframe.

IL-76MDK/IL-76MDK-II zero-G trainers

In 1987 a follow-on version designated IL-76MDK was derived from the IL-76MD. Outwardly it differs from the IL-76K only in having 'IL-76MDK' nose titles; the gunner's station is again deleted and replaced with an anti-spin 'chute canister.

Captained by V. I. Sviridov, the IL-76MDK prototype registered CCCP-76766 (c/n 0073481431, f/n 6108) made its first flight in Tashkent on 6th August 1988. This was followed by a second example, CCCP-78770 (c/n 0083487617, f/n 6605). Once again these aircraft are probably conversions of standard *Candid-Bs* (or IL-76MD 'Falsies'?). The State acceptance trials were led by Col. Anatoliy Andronov, chief of the Soviet Air Force's flight test department.

The next zero-G trainer, CCCP-78825 (c/n 1013495871, f/n 7208), was designated IL-76MDK-II (sometimes rendered as IL-76MDK-2). The difference between this version and the IL-76MDK is not known; anyway, CCCP-78825 is outwardly identical to the two preceding aircraft. The IL-76MDK-II entered flight test on 25th April 1990 and completed the trials programme on 7th August 1990. Reregistered RA-78825, it was displayed statically at the ILA-94 airshow at Berlin-Schönefeld with the exhibit code 164.

IL-76PP ECM aircraft (*izdeliye* 176)

In the mid-80s the IL-76MD evolved into a specialised electronic countermeasures version developed jointly with the Beriyev OKB and designated IL-76PP (*postanovschchik pomekh* – ECM aircraft); some sources refer to it as izdeliye 176. It featured the Landysh (Lily of the valley) ECM suite.

The appearance of this aircraft was anything but conventional. Large teardrop antenna fairings were ideally positioned on the forward and rear fuselage sides to give 360° coverage. They were identical to those of the Ilyushin/Beriyev A-50 airborne warning and control system (AWACS) aircraft described later in this chapter. Smaller antenna blisters and numerous blade aerials were located on the main gear fairings. More equipment was housed in large cylindrical pods at the wingtips with dielectric front and rear portions.

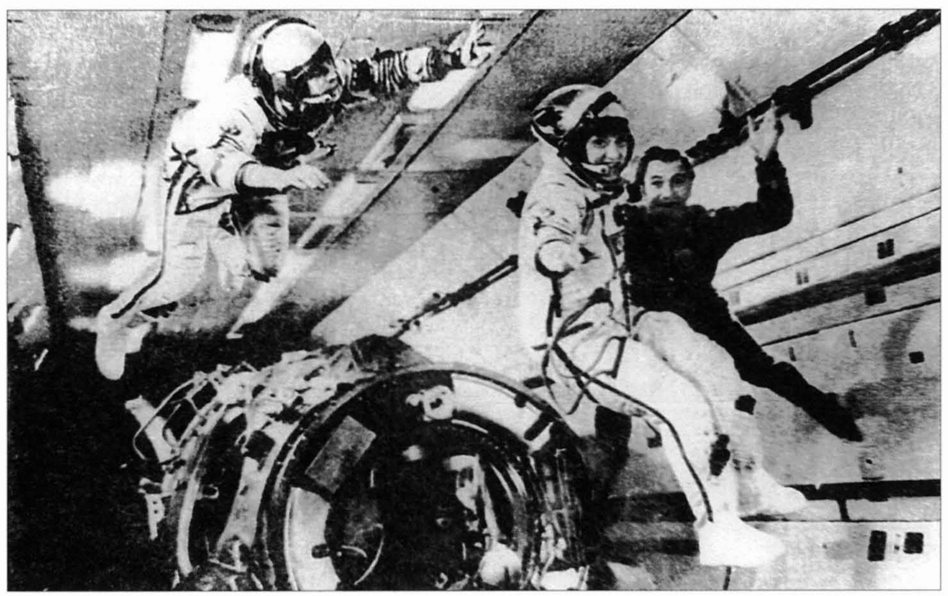
The ECM suite used a lot of power which the engine-driven generators could not provide. Hence two mighty gas turbine power units were installed in huge fairings on the forward fuselage sides which blended into the main gear fairings. Each unit was a 2,820-ehp (2,103-kW) Ivchenko AI-24VT turboprop engine (the type used on the An-24 airliner, An-26 *Curl* transport and An-30 *Clank* photo survey aircraft) driving four 90-kilowatt GT-90PCh6A three-phase AC generators. The fairings had large circular air intakes at the front and downward-angled jetpipes at the rear.

The ECM suite necessitated some airframe changes. The power unit fairings overlapped the entry doors which had to be modified (a small part of each fairing swung open together with the door and the handle was relocated). The mission equipment obstructed the forward emergency exits, so these were deleted and the windows moved up. The TA-6A APU was moved to the rear portion of the port main gear fairing, receiving a dorsal 'elephant's ear' intake and a downward-angled exhaust in similar fashion to the A-50.

The aircraft sported large cylindrical antenna pods on the wingtips which carried the navigation lights; their front and rear portions were dielectric, with prominent ventral 'outgrowths'. Additional antenna blisters were located on the power unit fairings, between the main gear struts and under the wingtip pods. Four blade aerials were mounted each side near the main gear units; the forward pair was raked aft and the aft pair forward. The front ends of the mainwheel fairings incorporated non-standard cooling air intakes. Apparently someone decided that active jamming wasn't enough, so chaff outlets were provided in the cargo ramp.

Four IL-76MDs, including CCCP-86889 (c/n 0013434009, f/n 2603), were reportedly converted at the Beriyev facility in Taganrog and delivered to NII VVS for trials. The IL-76PP was tested at the Chornaya Rechka (Black River) test range near Tashkent but its performance was disappointing. The ECM suite proved to be rather unreliable, used too much power and had poor electromagnetic compatibility. The aircraft was evaluated by the Air Force, reputedly even deploying to Cuba, but did not enter service. CCCP-86889 is now a ground instructional airframe at the Irkutsk Military Technical School (IVATU – ***Irkoot**skoye vo**yen**noye aviatsi**on**no-tekh**nich**eskoye oochi**li**schche*).

IL-76MD CCCP-76655 (c/n 0053463885, f/n 4802) was also reported as an IL-76PP. However, this aircraft was rather different. Apart from the wingtip pods and large ECM blisters on the forward fuselage sides, it was a perfectly ordinary *Candid-B*. There were no monstrous cheek fairings, no rear ECM antennas, and the main gear fairings, APU placement and emergency exits were unchanged. It seems highly unlikely that the



Yefim Gordon archive

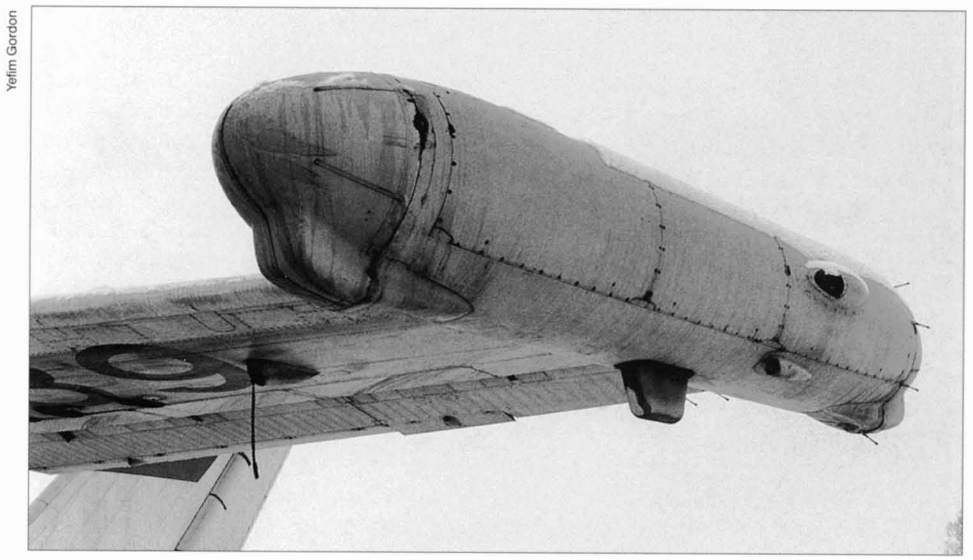
Soviet cosmonauts float around the cabin of an IL-76MDK in zero-G conditions, with a mock-up of a Soyuz spaceship module behind them. Female cosmonaut and test pilot Svetlana Ye. Savitskaya is in the centre.

Yefim Gordon

IL-76PP CCCP-86889 (c/n 0013434009, f/n 2604) languishes on a snow-covered ramp at the Irkutsk Military Technical College. The aircraft's development problems could not be overcome and it ended up 'out in the cold' as a teaching aid.

Viktor Drushlyakov

Above: Redolent with Cold War intrigue, this shot of IL-76PP CCCP-86889 coming in to land at Zhukovskiy shows the monstrous cheek fairings housing the turbine-driven power packs, the fuselage-mounted ECM antenna fairings and the wingtip antenna pods.



Yefim Gordon

Close-up of the port wingtip pod of the IL-76PP. The front and rear portions are dielectric, hiding emitter antennas.

aircraft had the gas turbine power units and all associated changes and was later reconverted to standard – the modification is simply too extensive.

The wingtip pods, too, were different from those of CCCP-86889, being somewhat smaller in diameter and lacking the ventral bulges; their dielectric portions and the ECM blisters were painted white. Also, unlike CCCP-86889, this aircraft featured built-in APP-50 chaff/flare dispensers.

Whatever mission equipment had been installed in the freight hold was removed by 1991, since CCCP-76655 was used on regular transport flights, carrying personnel to and from Germany during troop rotation in the Western Group of Forces. Based at Melitopol'-2 AB, the aircraft later became UR-76655 with the Ukrainian Air Force.

IL-76 – Tu-160 tailplane transporter

Shortly after the Tu-160 *Blackjack* strategic bomber attained initial operational capability with the 184th GvTBAP (*Gvar**dey**skiy tyazhe**lo**bombardi**rov**ochnyy **a**via**polk*** – Guards heavy bomber regiment) at Priluki AB in the Ukraine, the VVS began experiencing structural strength problems with the bomber's slab stabilisers (stabilators). Fatigue cracks appeared and on several occasions fragments of the horizontal tail broke away in flight, forcing the Tupolev OKB to ground the bombers and undertake an urgent redesign.

Eventually all Tu-160s built in 1990-91 had to have their stabilisers replaced with reinforced units, and an immediate problem arose: the new stabilators were too large to be carried internally by any freighter in VVS service. The solution was to carry them externally, as had been the case with wings for the An-124 Ruslan widebody freighter. (These were manufactured in Tashkent and carried to Kiev and Ul'yanovsk by two specially modified An-22 prototypes, CCCP-64459 and CCCP-64460, designated An-22PZ (for *pere**voz**chik* – carrier).

Thus, military IL-76 *sans suffixe* CCCP-76496 (ex-YI-AIN?, c/n 073410301, f/n 0806) owned by the Kazan' aircraft factory No.22 was modified to carry complete Tu-160 horizontal tail assemblies from Kazan' to Priluki AB where the old stabilators were replaced *in situ*. The stabilators were mounted atop the fuselage immediately aft of the wings on special struts; hence the aircraft was popularly known as the triplahn (triplane). The first flight in this configuration took place on 30th October 1986; when the Tu-160 stabilator problem had been solved, CCCP-76496 was reconverted to standard configuration.

IL-76MF military transport

From the start the IL-76 had obvious growth potential. The general development trend for transport aircraft in this class has been towards a roomier freight hold rather than bigger payload. Quite often a load that weighed far less than the IL-76 could carry could not be transported because it was too long to fit into the hold. Thus, the aircraft's capabilities could be enhanced a great deal by stretching the fuselage and fitting more powerful and fuel-efficient engines.

Development of the US counterpart, the Starlifter, showed this was the right approach. In January 1977 the C-141A evolved into the C-141B with a 7.11-m (23 ft 4 in) fuselage stretch and flight refuelling capability. All but two Starlifters were eventually converted to C-141B standard.

Preliminary development of the '*Candid* Plus' began almost simultaneously with the C-141B; it was initiated by an MAP directive issued on 1st January 1976. Putting the idea into practice, however, took nearly twenty years. While the fuselage stretch was the easy bit, the choice of powerplant proved to be a problem. The D-30KP had no reserves for further uprating. Originally the aircraft was to be powered by 14,000-kgp (30,864-lbst) turbofans developed by RKBM (***Ryb**inskoye kon**strook**torskoye byu**ro** mo**tor**ostro**yen**iya* – the Rybinsk Engine Design Bureau) but this engine never materialised.

As a stopgap measure, Ilyushin contemplated the 13,000-kgp (28,660-lbst) Kuznetsov NK-86 turbofan powering the IL-86. However, like the D-30KP, this engine had no growth potential, being in fact a spin-off of the good old NK-8 which powers the IL-62 *sans suffixe* and early versions of the Tu-154. The thrust increase was just too small and the idea was dropped.

Yefim Gordon

The first prototype IL-76MF, ИС 76900 (ie, IS 76900, c/n 1053417563, f/n 9001) makes a demonstration flight at the MAKS-95 airshow when the new version was publicly unveiled. The freighter showed surprising agility for an aircraft of its size

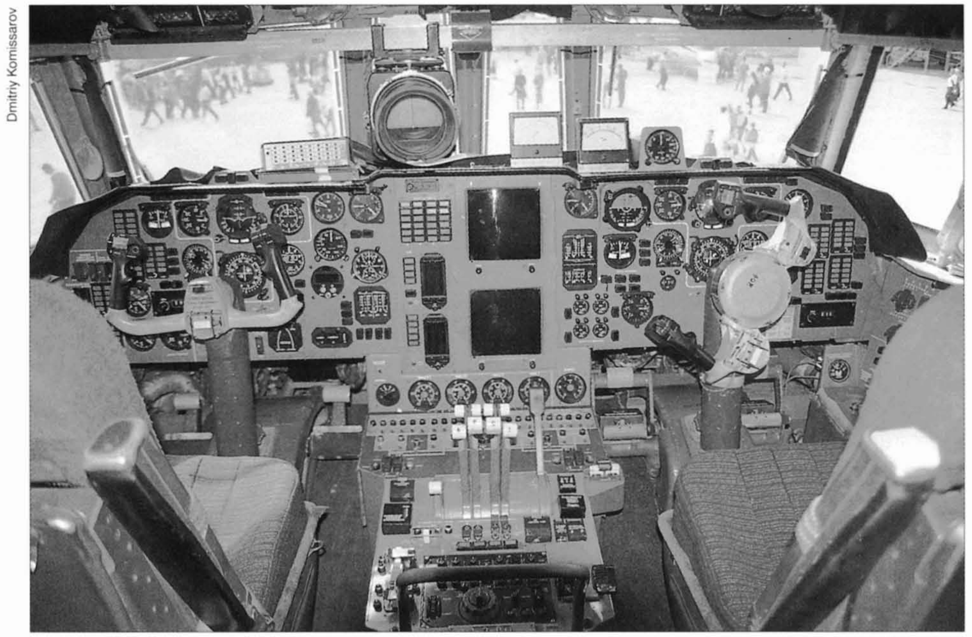
However, in the early 1980s the Solov'yov OKB started work on a new turbofan, the D-90 intended for the Tu-204 medium-haul airliner (the engine was renamed PS-90 in 1987). Initially delivering 12,500 kgp (27,560 lbst), it was uprated to 15,000 kgp (33,070 lbst) and then to 16,000 kgp (35,270 lbst) in due course; this brought about a change in the Tu-204's configuration from a 'Lockheed TriStar gone on a diet' lookalike to the current twinjet. The PS-90 incorporated all the latest features, including full authority digital engine control (FADEC).

Hence the IL-76 stretch project was revived in the late 1980s as the IL-76MF; the F is an allusion to the stretched fuselage. Two 3.3-m (10 ft 9.92 in) plugs are inserted ahead of and aft of the wings, increasing freight hold volume 1.5 times to 400 m^3 (14,125 cu ft). This allows such loads as four 20 ft containers to be transported and, of course, substantially increases capacity in troopship configuration, allowing the aircraft to carry up to 500 servicemen. This, in turn, required the addition of two pairs of emergency exits (one ahead and one aft of the wings). The wing/air intake inspection light fairing ahead of the port entry door is deleted; this light is now buried in the fuselage about halfway between the door and the foremost emergency exit. A pair of taxi lights (runway turnoff lights) is installed symmetrically at the same location.

The aircraft has a *Candid-A* style pointed tailcone – the gunner's station is eliminated to save weight. The ECM antennas, instead of being placed on the forward/aft fuselage sides, are faired into the wingtips on the IL-76MF in order to reduce drag.

The IL-76MF is powered by PS-90A-76 turbofans. The new engine has a much larger casing diameter and a cascade-type thrust reverser with translating cowl. Hence the engine pylons and nacelles had to be designed from scratch (the leading edge of the pylon is curved where it joins the nacelle; also, the leading and trailing edges are no longer parallel). The production-standard PS-90A has a 15% lower specific fuel consumption than the D-30KP and much lower noise and emission levels – an important point, considering all those ICAO annexes regarding noise and pollution.

The aircraft's systems and equipment are thoroughly updated. The Koopol ground mapping radar is replaced by an upgraded Koopol-3 model; a 'glass cockpit' with multi-function colour LCDs is introduced, along with new communications equipment, allowing the radio operator to be automated away. The TA-6A APU is replaced by a TA-12-60 unit; this is also a Stoopino Machinery Design Bureau product and is used on some other aircraft powered by the PS-90 (the Tu-204 and the projected Tu-330). Originally, the Omsk Engine Design Bureau VGTD-43 (vspomogahtel'nyy gahzotoorbinnyy dvigatel' – auxiliary gas turbine engine) was envisaged, but development of this APU took rather longer than expected.



Dmitriy Komissarov

The flightdeck of the IL-76MF prototype. Note the two large cathode-ray tube displays in the centre. The instruments at the top (to the right of the radar display) are test instrumentation.

MTOW is increased to 210 tons (462,962 lb) and payload to 52 tons (114,638 lb). Nevertheless, the fuel-efficient engines afford a 15 to 20% increase in range. The wing structure had to be reinforced, of course, to cater for the higher gross weight.

The IL-76MF was unveiled in model form at MosAeroShow '92 in August 1992.

Construction of the first prototype (c/n 1053417563, f/n 9001) began in Tashkent in February 1994. The OKB chose to build the aircraft from scratch rather than cut up an existing airframe and insert plugs (as had been the case with the IL-96M prototype, RA-96000, which was converted from the first prototype IL-96-300). The rollout was planned for the end of the year but funding shortfalls caused construction to drag on until early 1995.

By then Ilyushin had some operational experience with the PS-90A, and unfortunately this was not all positive. Reliability was rather poor at first (Aeroflot's IL-96-300s had 32 unscheduled engine changes in the first two years of service). Hence the engine was temporarily derated to 14,500 kgp (31,966 lbst) by making changes to the FADEC software and it was this derated version that powered the prototype. The aircraft was unarmed, but the inert gas generator intake in the starboard main gear fairing, the characteristically reprofiled wingtips incorporating ECM antennas and the 'Ready – Go!' sign in the freight hold left no doubts that this was indeed an IL-76MF, not a civil IL-76TF (see below).

Originally the first flight date was set for May 1995, then for late July, but kept slipping for various reasons. Finally, at 10.24am Moscow time on 1st August the IL-76MF took to the air at long last. The mixed Russian-Uzbek crew was captained by Ilyushin test pilot (1st Class) Anatoliy N. Knyshov and included first officer V. I. Sviridov, navigator B. A. Tver'ye, flight engineer S. N. Goryunov, radio operator Ye. E. Bokoonovich (yes, there was a radio operator that time) and electrics engineer Yuriy G. Bliznyuk. Yuriy M. Arandt was the engineer in charge of the tests. The 35-minute flight went smoothly.

For the maiden flight the aircraft was registered 17563 without any country prefix; this was the 'famous last five' of the c/n, which is common practice at Tashkent). On 7th August, however, the IL-76MF was reregistered ИС 76900 (that is, IS 76900). The unusual prefix in Cyrillic characters – which was unheard-of in post-Soviet times – denoted *ispy**ta**niya* (tests or trials). This avoided the touchy issue of whether the prototype belonged to the OKB in Russia or the plant in Uzbekistan (and thus whether it should be registered RA-76900 or UK-76900). For the same reason the prototype carried both Russian and Uzbek flags on the fuselage.

The following day the aircraft arrived in Zhukovskiy to continue its flight test programme. The IL-76MF was one of the stars of the MAKS-95 airshow (22nd-27th August), making its tenth flight by closing day. The public was allowed inside the freight hold which was lined with racks of test equipment, but, understandably enough, the flightdeck was off limits.

Yefim Gordon

Above: The IL-76MF completes its landing run at Zhukovskiy, streaming the Russian and Uzbek flags from the flightdeck roof escape hatch.

From 5th to 10th November 1996 the aircraft had its international debut at Airshow China '96 in Zhuhai (Sanzao airport); the crew was captained by Stanislav G. Bliznyuk. Now using the unofficial IS- prefix was no longer possible and the prototype had to be reregistered RA-76900 for the occasion.

On 11th April 1997 the IL-76MF was certificated according to ICAO Annex 16 Chapter 3 and FAR Pt 36 noise regulations. In the same year RA-76900 took part in the 42nd Paris Aerospace Salon at Le Bourget (15th-22nd June) with the exhibit code 338 and in the MAKS-97 airshow (19-24th August). It was also on display at ILA'98 with the exhibit code 236 and at MAKS-99 (17th-22nd August 1999).

By November 1999 the second IL-76MF (c/n 1063421724, f/n 9401) had been rolled out in Tashkent. The still engineless and unpainted aircraft differed from the first prototype in having four external stores pylons under the outer wings *à la* IL-76MD. Eight more examples and the commercial IL-76TF prototype were reportedly in various stages of completion. The Russian Air Force, which had announced its intention to purchase the type, was due to take RA-76900 on loan for evaluation in late 1997. On 15th March 1996 the Commander of the VTA stated that the IL-76MF would be one of the three types operated by the Russian Air Force's transport element in the 21st century (alongside the An-70 and Tu-330VT, that is).

During the last days of June 2000 the first prototype demonstrated its paradropping capabilities to Russian Air Force and Airborne Forces top brass (including VDV C-in-C Col. Gen. Gheorgiy Shpak) at Dyaghilevo AB near Ryazan'. In so doing it achieved a 'world first' by dropping six cargo pallets – two with BMD-2 IFVs and four with ammunition crates, followed by a load of paratroopers.

In due course the IL-76MF's maximum payload increased to 60 tons (132,275 lb). This was demonstrated in May 2000 when RA-76900 delivered 60 tons of cargo to Pevek on the Chukotka Peninsula. As of October 2000 Ilyushin had invested US$ 20 million into IL-76MF development; with no state funding, the company is forced to fly commercial cargoes on the prototype in order to finance the completion of the trials programme!

Ilyushin is also targeting the export market with the IL-76MF; an export price of US$ 30-35 million was quoted in late 1995 for the Russian-engined version. Export aircraft could be powered by Western engines – 14,150-kgp (31,200-lbst) CFM International CFM56-5C2 or 17,330-kgp (38,200-lbst) Pratt & Whitney PW2337 turbofans – and equipped with Western avionics at customer request.

Viktor Drushlyakov

The second prototype IL-76MF (c/n 1063421724, f/n 9401) on the factory apron at Tashkent-Vostochnyy. The engine in the foreground is not meant for this aircraft, being a D-30KP.

IL-76TF commercial transport

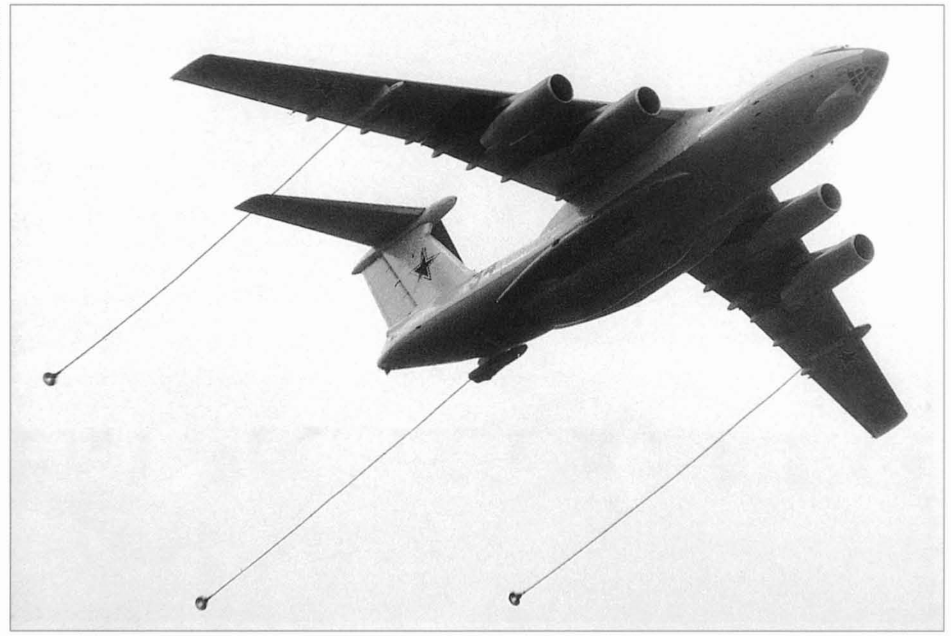
This is the civil equivalent of the IL-76MF (the commercial version has also been referred to as IL-76MT by some sources). It differs from the military version in lacking paradropping equipment, the inert gas generator and ECM equipment (and hence having ordinary wingtip fairings); the communications suite is probably slightly different, too.

The stretched fuselage enables the aircraft to carry four 20 ft air/sea/land containers instead of three, nine UAK-5 cargo containers instead of six or two coaches instead of one. Additionally, special double-deck modules can be installed for carrying up to 24 passenger cars.

IL-78 (IL-78T) *Midas* refuelling tanker/transport

Aerial refuelling had been a sore spot for the VVS for years. Tactical aviation had to do without, and only a few bombers had flight refuelling capability. These were Tu-4s and Tu-16s equipped with the Soviet wingtip-to-wingtip system developed by Igor' Shelest and Viktor Vasyanin in 1948. The tanker deployed a hose stabilised by a drogue parachute from the starboard wingtip and the receiver aircraft placed its port wingtip over the hose. Then the hose was rewound until the fitting at the end engaged a receptacle under the receiver aircraft's wing. The receiver increased speed so that the hose formed a loop and rotated the receptacle, opening a valve, whereupon fuel transfer could begin.

This technique was complicated; worse, a Tu-16Z *Badger-A* (Z = *za**prahv**shchik* – tanker) could only refuel other Tu-16s. Hence the VVS soon switched to the hose-and-drogue system. This offered greater versatility, since Tu-16N *Badger-A* and Myasishchev M-4-2 *Bison-A*, 3MS2 and 3MN2 *Bison-B* tankers could work with any aircraft fitted with the standard refuelling probe. Yet again the Tu-16N and M-4-2 *et seq.* were single-point tankers, with the hose drum unit (HDU) installed in the bomb bay. Meanwhile, by the late 1970s the Western air forces had introduced three-point tankers; the VVS had a requirement for a similar aircraft.



Yefim Gordon

IL-78 '34 Blue' (c/n 1013404138, f/n 7905) streams all three fuel transfer hoses during an airshow performance. This example features an IL-78M-style L-shaped pylon for the fuselage HDU.

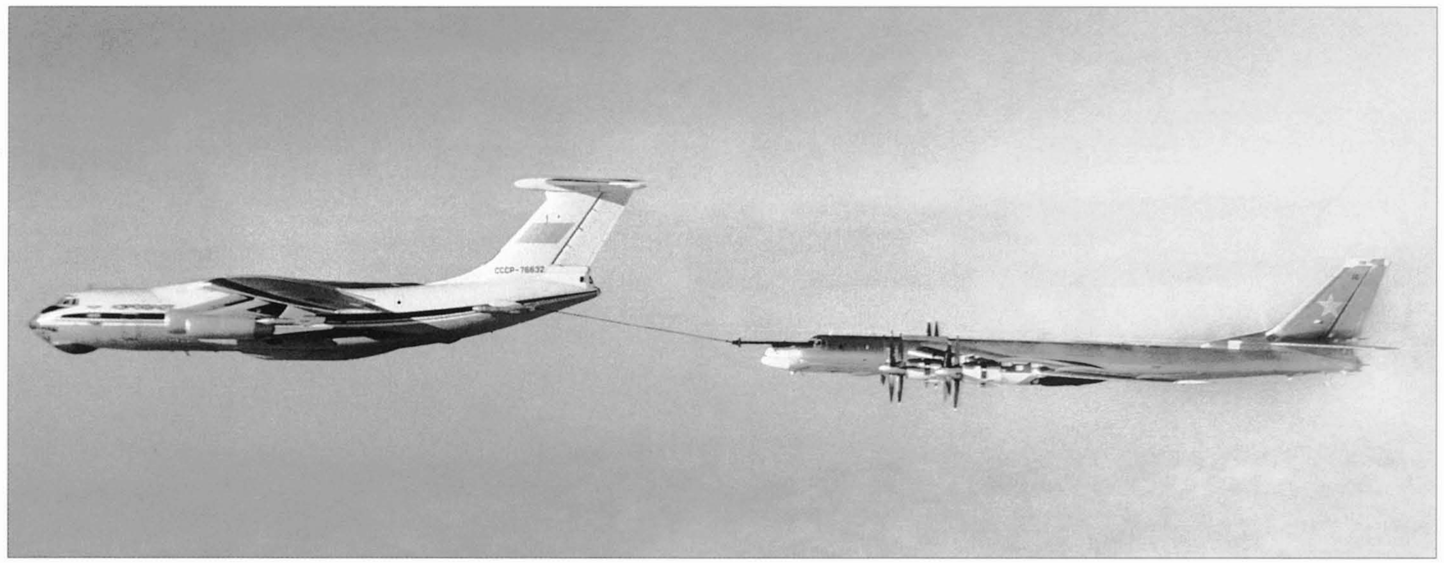
Development of the IL-78, as the tanker/transport derivative of the *Candid* was designated, began pursuant to an MAP and VVS order issued on 14th March 1968 – three years before the IL-76 flew! However, calculations showed that the IL-76 *sans suffixe* adapted to the tanker role could transfer only 10 tons (22,045 lb) of fuel; this was insufficient and the project was shelved.

Interest in the idea revived when the high gross weight IL-76MD with increased fuel capacity came on the scene. On 10th March 1982 the Council of Ministers and the Central Committee of the Communist Party issued a directive ordering the development of the IL-78, and the design effort was completed in the following year. Development was led by project chief Radiy P. Papkovskiy, aided by G. K. Nokhratyan-Torosyan, A. V. Leschchiner and Dmitriy V. Leschchiner, A. L. Dobroskov, G. V. Mashkov and N. F. Makokin.

The aircraft is equipped with three UPAZ-1A Sakhalin refuelling pods (UPAZ = *oonif**itsee**rovannyy podves**noy** agre**gaht** zaprahvki* – 'standardised suspended (that is, external) refuelling unit' or HDU). They were developed by the Zvezda (Star; pronounced zvez**dah**) design bureau (formerly OKB-918) under G. I. Severin – the company responsible for the famous K-36 ejection seat.

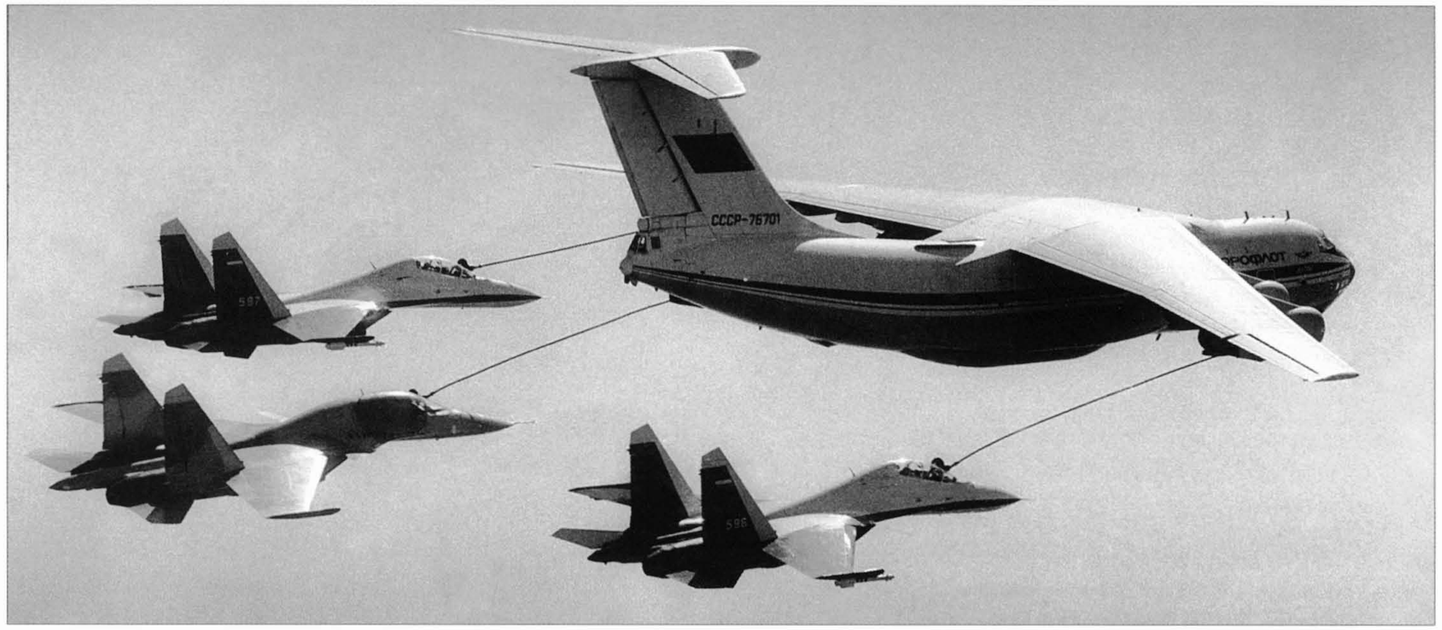
Two pods are conventionally mounted on pylons under the outer wings. The third pod is suspended from a short horizontal pylon on the port side of the aft fuselage; this is a unique arrangement not used by any other tanker.

The UPAZ-1A has a 26-m (85 ft 3⅜ in) hose and a flexible 'basket' drogue. The hose drum is powered by a ram air turbine (RAT) with an opening intake scoop on the port side at the rear. A second air intake at the front closed by a movable cone is for the RAT driving a generator for the electric transfer pump. Normal delivery rate is 1,000 litres/min (220 Imp gal/min) but this can be increased to 2,200 litres/min (484 Imp gal/min) in case of need. 'Traffic lights' are installed at the rear end of the pod to indicate fuel transfer status to the pilot of the receiver aircraft.



Ilyushin Aviation Complex

IL-78 CCCP-76632 (c/n 0053459757, f/n 4410) refuels a Tu-95MS-6 bomber during trials.



Yefim Gordon archive

Above: CCCP-76701, the IL-78M prototype, simulates the refuelling of two Su-30s ('596 White' and '597 White') and the Su-27IB prototype ('42 Blue').

Most of the fuel is carried in the standard wing tanks. Additionally, two cylindrical metal tanks connected to the aircraft's fuel system, each holding 18,230 litres (4,010.6 Imp gal) or 14 tons (30,860 lb) of fuel, are installed in the freight hold. These can be easily removed if required, allowing the aircraft to be used for transport or paradropping duties, since the cargo doors and cargo handling equipment are retained. Hence the initial tanker version is also referred to sometimes as IL-78T (***trahnsport**nyy*). The IL-78 can also refuel other aircraft on the ground (up to four at a time), using conventional hoses routed through the entry doors.

The wing tanks hold 90 tons (198,410 lb) of fuel; the extra tanks in the fuselage increase this to 118 tons (260,141 lb) or 153,652 litres (33,803 Imp gal). Maximum transferable fuel with or without fuselage tanks is 85,720 or 57,720 kg (188,980 or 127,250 lb) respectively, which amounts to 111,620 or 75,160 litres (24,556 or 16,535 Imp gal) respectively. Take-off weight is 190 tons (418,870 lb) on paved runways and 157.5 tons (347,220 lb) on semi-prepared runways.

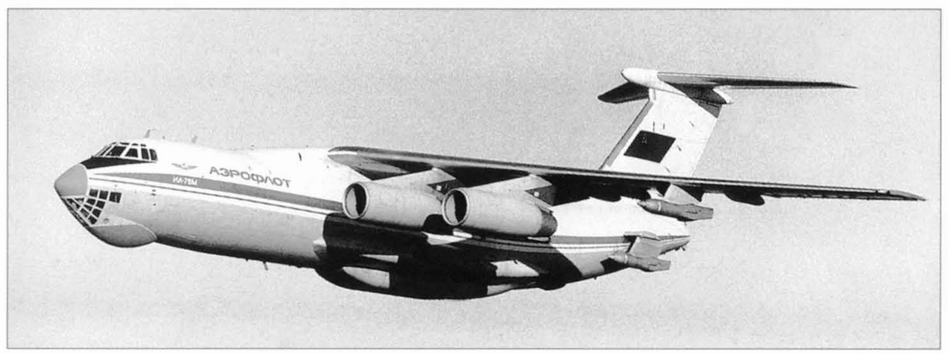
Unlike the *Candid-B*, the tanker is unarmed; the former gunner's station is occupied by the refuelling systems operator. Hence the tail turret is replaced by a characteristic dished fairing and the gun ranging radar is deleted, with a flat cover supplanting the radome. Another difference from the IL-76 is that the IL-78 has a fuel jettison system; the fuel jettison pipes are located at the wingtips.

With a 1,000-km (540-nm) combat radius the IL-78 can transfer up to 65 tons (143,300 lb)/84,639 litres (18,620 Imp gal) of fuel. Maximum combat radius with 32-36 tons (70,545-79,365 lb) of transferable fuel (equalling 41,668-46,877 litres/9,167-10,313 Imp gal) is 2,500 km (1,550 miles). It is possible to refuel one heavy bomber, using the centre pod, or two tactical aircraft, using the underwing pods.

Refuelling is done at 2,000-9,000 m (6,560-29,525 ft) and 430-590 km/h (267-366 mph) (some sources say 400-600 km/h; 248-372 mph). The minimum safe distance between the tanker and receiver aircraft is 13 m (42 ft). Refuelling is allowed in direct visibility conditions only. Two lights in characteristic fairings under the refuelling systems operator's station illuminate the lower rear fuselage during night refuelling; this gives the pilot of the receiver aircraft a visual reference, minimising the danger of collision.

To ensure rendezvous with the receiver aircraft the IL-78 is equipped with an additional RSBN-7S Vstrecha (Rendezvous) SHORAN system (RSBN = ***ra**hdiotekh**nich**eskaya sis**tem**a **blizh**ney navi**gah**tsii* – short-range radio navigation system) with three antennas built into the fin each side instead of one on the IL-76; these provide mutual detection and approach at up to 300 km (186 miles). Also, the usual stabiliser inspection light buried in the rear portion of the starboard main gear fairing is augmented by two more lights – presumably for checking the port and centre refuelling pods in icing conditions.

Wearing the out-of-sequence registration CCCP-76556 (c/n 0033445294, f/n 3304), the IL-78 prototype made its first flight in Tashkent on 26th June 1983 with OKB test pilot Vyacheslav S. Belousov at the controls. Ilyushin CTP Stanislav G. Bliznyuk flew the aircraft later when refuelling techniques were practiced. Manufacturer's flight tests took place between September and December 1983, followed by State acceptance trials which began in March 1984 and were completed on 30th June; once again, Col. Anatoliy Andronov was in charge. CCCP-76556 was retained by the OKB and used for test and development work together with the Mikoyan and Sukhoi bureaux, LII and so on.



Ilyushin Aviation Complex

This view of the IL-78M prototype (c/n 0063471139, f/n 5405) illustrates the L-shaped pylon of the centre UPAZ-1 HDU moving the drogue away from the turbulent airflow around the fuselage. What is not apparent in this view is the lack of the cargo doors.

Deliveries to the VVS began in 1984 (the first five aircraft went to the VTA training centre at Ivanovo-Severnyy AB), but it was not until 1st June 1987 that the tanker was officially included into the Soviet Air Force inventory. The 409th SAP (***smesh**annyy **avi**apolk* – composite air regiment) at Uzin AB near Kiev was the main operator of the IL-78.

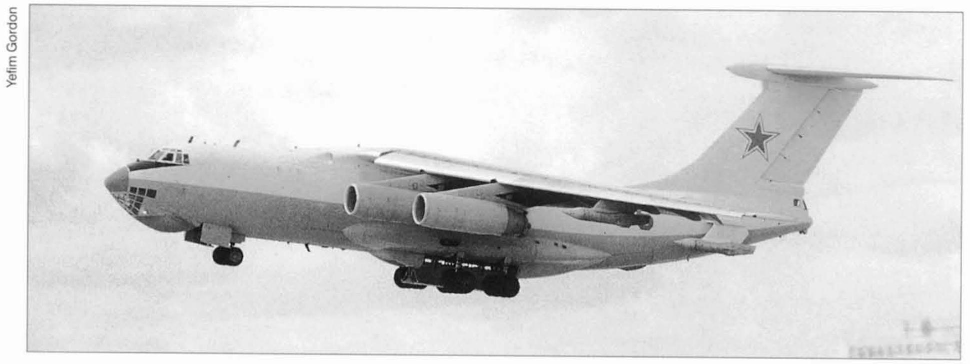
The West had been speculating on a possible tanker version of the IL-76 since 1980; by 1986 the aircraft had been assigned the reporting name *Midas*. On 2nd August 1988 US Secretary of Defense Frank C. Carlucci and his senior aide Maj. Gen. Gordon E. Fornell visited Kubinka airbase, examining the latest Soviet military aircraft, including the IL-78, and the true designation was revealed.

The tanker at Kubinka had an Aeroflot-style paint job and VVS insignia (but no tactical code). This was highly unusual because, despite their obvious military role, the IL-78s usually wore Aeroflot colours and civil registrations.

Some aircraft were seen carrying only the underwing UPAZ-1A pods or the fuselage pod. Late production IL-78s had the fuselage pod mounted on an L-shaped pylon identical to that of the IL-78M (see below). Accompanied by a Tu-95MS-6 *Bear-H* bomber and four escorting MiG-29s, one such aircraft painted in a grey/white Air Force colour scheme and coded '34 Blue' (c/n 1013404138, f/n 7905) took part in the demonstration flights at the Kubinka-92 open doors day on 11th April 1992, in what was probably the type's public debut. '34 Blue' is one of only two IL-78s *sans suffixe* known to wear overt military markings, the other one being '616 Black' (ex-CCCP-76616, c/n 0053455676, f/n 4209). Incidentally, the Tu-95/Tu-142 is said to have trouble refuelling from the IL-78 because of exhaust gas ingestion.

On 13th February 1992 IL-78 CCCP-76744 (c/n 0073478359, f/n 5910) was demonstrated to top-ranking military officials and the leaders of the CIS states at Machoolischchi AB near Minsk. Once again the aircraft had the civil markings painted out and VVS markings (but no tactical code) hastily applied for the occasion because the organisers felt it would be 'improper' to display a civil-registered aircraft.

Twenty aircraft in strength with the 409th SAP at Uzin AB were retained by the Ukrainian Air Force after the collapse of the Soviet Union. Since the Ukraine did not need tankers (the UAF's Tu-22M3 *Backfire-C* bombers were deprived of flight refuelling capability under the SALT-2 treaty), nearly all Ukrainian IL-78s have been converted into pure transports by removing all refuelling equipment, including the pylons. Some even have 'IL-76MD' nose titles, but the triple SHORAN antennas in the fin and the fuselage illumination lights under the refuelling systems operator's station reveal their true identity. Among aircraft thus converted are UR-76412 (IL-76TD 'Falsie', ex-CCCP-78773/to UR-UCF), UR-76414 (ex-CCCP-76774/to UR-UCG), UR-76415 (ex-76775/to UR-UCI), and so on.



Yefim Gordon

A production IL-78M coded '36 Blue' takes off on a demonstration flight during the MAKS-99 airshow.

Vestnik Aviatsii i Kosmonavtiki

Most IL-78Ms, such as '32 Blue' (1003403068, f/n 7707) seen here refuelling two MiG-31 interceptors, wear this grey/white colour scheme with overt military markings.

Viktor Drushlyakov

Above: The first of two IL-82 airborne command posts/communications relay aircraft (CCCP-76450) comes in to land at Zhukovskiy. This view shows clearly the dorsal 'hump', the ventral fairings, the underwing aerial pods and the rear blade aerials, with the drogue of the trailing wire aerial in between.

IL-78E Midas refuelling tanker

Unlike the *Candid*, the IL-78 has not been widely exported. Libya is the sole customer outside the former Soviet Union; in 1989 the Libyan Arab Air Force took delivery of a single aircraft registered 5A-DLL (c/n 0093493799, f/n 7010). The export version is designated IL-78E (***eks**portnyy*). (To be precise, India is also reported to operate IL-78s but these are merely on loan from the Russian Air Force. Algeria also reportedly has a number of IL-78s but no details are known.)

IL-78M Midas refuelling tanker

On 20th December 1984, soon after the basic *Midas* completed its flight tests, the Council of Ministers and the Central Committee of the Communist Party issued a directive ordering the development of an upgraded tanker designated IL-78M. Unlike the IL-78 *sans suffixe*, this is a dedicated (non-convertible) tanker version. It features a third fuselage fuel tank increasing total fuel to 138 tons (304,230 lb) or 179,965 litres (39,533 Imp gal); transferable fuel is thus increased to 105,720 kg (233,070 lb) or 137,662 litres (30,285 Imp gal). MTOW on paved runways is increased to 210 tons (462,960 lb); this required the wing torsion box to be reinforced. Besides, the IL-78M is equipped with improved UPAZ-1M pods having a higher delivery rate (2,340 litres/min or 514.8 Imp gal/min).

The main external recognition features are the absence of the port entry door and the redesigned L-shaped pylon of the fuselage pod; the latter is caused by the need to move the drogue away from the turbulence generated by the fuselage. The cargo doors are deleted (this can be clearly seen from the transverse skin joint lines under the aft fuselage and the absence of outer door hinge fairings) and the cargo ramp is non-functional. This, together with the deletion of all cargo handling equipment, cut structural weight by roughly 5,000 kg (11,020 lb) at the expense of versatility. Finally, the wing/air intake inspection light is relocated to starboard, since there is no longer a window on the port side of the nose.

The IL-78M prototype, CCCP-76701 (c/n 0063471139, f/n 5405), entered flight test on 7th March 1987; again it was Vyacheslav S. Belousov who captained the aircraft on its maiden flight. Like the original IL-78 prototype, this aircraft was retained by Ilyushin and used for trials of tactical aircraft – for example, the ninth prototype Su-27M (Su-35), '709 Blue' (c/n 79871011001).

CCCP-76701 participated in the flying display at MosAeroShow '92, formating with two Sukhoi Su-30 multi-role fighters operated by LII's *Ispy**tah**teli* (Test Pilots) display team – '596 White' and '597 White' (c/ns 79371010101 and 79371010102) – and the experimental Su-27IB fighter-bomber ('42 Blue'), the precursor of the Su-34/Su-32FN. Unlike earlier demos of the same kind, all three receiver aircraft actually 'hit the tanker' in a simulated refuelling. By August 1997 the prototype (by then reregistered RA-76701) was withdrawn from use in Zhukovskiy.

Yefim Gordon archive

Another view of IL-82 CCCP-76450 during trials. The dorsal fairings on the rear fuselage are visible in this view, as is the starboard-side entry door; the one on the port side is deleted.

Unlike the basic IL-78 tanker/transport, production IL-78Ms usually have overt military markings and a grey/white Air Force colour scheme. Known aircraft are coded '30 Blue' through '33 Blue', '35 Blue', '36 Blue' and '50 Blue' through '53 Blue'. Only the first four production IL-78Ms, CCCP-78800 and CCCP-78822 through CCCP-78824, are quasi-civilian. The type is operated by the 230th APSZ (***avia**polk samo**lyo**tov-za**prahv**shchikov* – aerial refuelling regiment, = aerial refuelling wing) in Engels in southern Russia which had 12 (other reports say 20) aircraft on strength in early 1992. This unit was later disbanded and the tankers were transferred to the 203rd GvAPSZ at Dyaghilevo AB near Ryazan'.

Some sources claim 45 examples of both versions had been built by 1991; however, even without the six doubtful aircraft mentioned earlier we get 49 examples.

The IL-78M was also a regular participant at various airshows. For example, '30 Blue' was displayed at Kubinka in March 1992 during a show marking the 50th anniversary of the Russian Air Force's strategic bomber arm (DA, dahl'nyaya aviahtsiya – long-range aviation). '50 Blue' participated in the Tushino flypast on 9th May 1993 in a simulated refuelling of a Tu-95MS-6.

The flying display at the 1994 Kubinka open doors day (14th May 1994) featured two IL-78Ms. First, '35 Blue' formated with a Tu-95MS-6 escorted by two MiG-29s of the Strizhi (Swifts) display team and two Su-27 of the ***Roos**skiye **Vi**tyazi* (Russian Knights) team. Next came '30 Blue' in formation with two Su-24M *Fencer-D* tactical bombers ('91 Blue' and '93 Blue'), one of which was flown by Russian AF C-in-C Col. Gen. Pyotr S. Deynekin.

'30 Blue' and '36 Blue' took part in the grand military parade in Moscow on 9th May 1995 on occasion of the 50th anniversary of VE-Day. Finally, IL-78M '36 Blue' participated in the flying display at MAKS-99, demonstrating a simulated refuelling of Su-30s '302 Blue' and '597 White'.

IL-82 airborne command post/ communications relay aircraft (IL-76VKP, 'version 65S')

Two IL-76MD 'Falsies' built in late 1985, CCCP-76450 (c/n 0053463900, f/n 4805) and CCCP-76451 (c/n 0053464938, f/n 4905), were extensively converted at the Tashkent factory for the communications relay role. In the event of war these aircraft would ensure communication between the strategic nuclear forces and command, control and communications (C^3) centres – or IL-86VPU *Maxdome* national emergency airborne command posts (NEACPs) in case ground C^3 centres were knocked out (VPU = *voz**doosh**nyy poonkt oopravleniya* – airborne command/control post. The aircraft has also been referred to as IL-80 and as IL-86VKP). The manufacturer's designation of the comms relay *Candid*, the Soviet equivalent of the US Navy's Boeing E-6A Hermes, is IL-82; it was previously used for a projected 120-138-seat short-haul airliner powered by two Solov'yov D-30M-1 turbofans which was abandoned in favour of the Tu-134A. Some sources refer to the aircraft as 'IL-76 version 65S'.

Yefim Gordon

Above: The second IL-82, CCCP-76451, parked at Zhukovskiy. Note the faired-over navigator's station glazing and the much-reduced flightdeck glazing area.

The aircraft has some equipment commonality (and hence common exterior features) with both the IL-80 and the A-50 AWACS. Recent publications say it also has an airborne command post role, hence the alternative designation IL-76VKP (*voz**doosh**nyy ko**mahnd**nyy poonkt* – ABCP).

The IL-82 is immediately recognizable by the large boxy dorsal canoe fairing (similar to that of the *Maxdome*) which runs the full length of the forward fuselage from flightdeck to wing leading edge. This houses satellite communications and navigation equipment. The navigator's glazing, cockpit eyebrow windows and the two rearmost flightdeck windows on each side are deleted. So is the port entry door but, illogically, the engine/wing inspection light remains on the port side where there's no window to inspect the intakes through!

The main gear fairings are borrowed from the A-50, with much thicker and blunter forward portions, though the starboard fairing has one circular intake instead of two. The APU is housed in the aft portion of the port fairing, with an 'elephant's ear' intake. A second APU is located symmetrically to starboard; this is because the APUs are used to power the mission equipment in flight. The starboard fairing also has prominent bulges over equipment at the rear. A long shallow fairing with small blade aerials runs along the lower port side of the fuselage from the nose gear to the port mainwheel fairing; two small canoe fairings with blade aerials are located in tandem symmetrically to starboard.

Two small streamlined pods with forward-pointing HF probe aerials are carried on short strut-braced pylons under the outer wings. Additionally, CCCP-76450 had small hemispherical fairings under the wingtips. Two small blade aerials are located side by side just aft of the wing leading edge, with three more in a triangle (facing the tail) at the trailing edge. The dorsal fin is flanked by two elongated semi-cylindrical antenna fairings *à la* IL-80.

The outer cargo doors are modified; their rearmost portions are fixed and carry huge outward-canted blade aerials. A very low frequency (VLF) trailing wire aerial with a stabilising drogue is faired into the centre door segment; this is used for communication with submerged nuclear submarines. After deploying the 5-km (3.1-mile) TWA the IL-82 starts circling and the drogue stalls so that the wire droops almost vertically; this is the only way for the radio signals to penetrate deep water. A similar aerial with a float is deployed by the sub.

Conversion and outfitting took more than a year, though this could be partly accounted for by delays in equipment delivery. CCCP-76450 made its first flight on 29th April 1987, captained by Yuriy V. Mazonov. Both aircraft were ferried to LII, and the existence of the new version came to light on 16th August 1988 during the Aviation Day flypast in Zhukovskiy. Curiously, this highly specialised version never received a separate NATO codename.

After completing their trials successfully the two IL-82s were delivered to the 8th ADON at Chkalovskaya AB. Needless to say they spend most of their time in storage.

Vyacheslav Martyniuk

Above: An early-production A-50 *sans suffixe* comes in to land at Ivanovo-Severnyy. Note the AWACS Squadron badge aft of the flightdeck.

Ilyushin/Beriyev A-50 *Mainstay-A* AWACS (IL-76A)

Chronologically this was probably the second military version of the *Candid* to have a separate designation. It owed its existence to the need to replace the Tu-126 *Moss* airborne warning and control system (AWACS) aircraft. Derived from the Tu-114 *Cleat* four-turboprop long-range airliner, the Tu-126 had been in service with the Soviet Air Defence Force (PVO – *protivovozdooshnaya oborona*) since 1961 and had become obsolescent by the early 1980s.

Actually work on a successor to the Tu-126 had begun as early as 1965 when the Beriyev OKB experimentally fitted an An-12BP with a surveillance radar in a conventional rotodome. Performance was poor (to say nothing of the fact that the *Cub* is unpressurised) and the project was abandoned. However, a logical explanation is that the aircraft was nothing but an avionics testbed.

On 7th August 1969 the VPK tasked the Ilyushin OKB with preliminary development of the IL-70 AWACS, a derivative of the as-yet unflown IL-76. (The designation IL-70 had been used in 1961 for a projected 24-seat regional airliner powered by two Tumanskiy R19M-300 turbojets; development was discontinued in 1963). With its high speed, payload and range the *Candid* was an excellent AWACS platform.

Thus in the late 1970s the IL-76M evolved into the A-50. The 'non-Ilyushin' designation is due to the fact that the aircraft is a joint effort with the Beriyev OKB and the Taganrog machinery plant No.86 named after Gheorgiy Dimitrov (TMZD – *Taganrogskiy mashinostroitel'nyy zavod imeni Gheorgiya Dimitrova*) which integrated the mission avionics suite. (Cf. A-40, the manufacturer's designation of the Beriyev Be-42 Albatross (*Mermaid*) ASW amphibian.) Had Ilyushin alone been responsible for the job, the designation would have been something like IL-76RLD (*rahdiolokatsionnyy dozor* – radar picket) – or IL-70. At the Tashkent Aircraft Production Corporation which manufactures the airframe, however, the A-50 is referred to as IL-76A.

The A-50 is equipped with the Shmel' (Bumblebee) mission avionics suite built around a coherent pulse-Doppler 360° surveillance radar of the same name. The radar can track up to 50 targets at a time with a maximum range of 230 km (142 miles); large targets like surface ships can be detected and tracked at up to 400 km (248 miles). The suite also includes an IFF system, a data processing and presentation system, data storage equipment and secure digital communications/data link equipment for communicating with ground and shipboard command, control, communications and intelligence (C^3I) centres centres and friendly fighters.

Yefim Gordon

A Russian Air Force A-50 completes its landing run at Akhtoobinsk in the mid-1990s. Note the weathered paintwork on the rotodome.

The radar was developed by the Moscow Research Institute of Instrument Engineering (MNIIP – *Moskovskiy naoochno-issledovatel'skiy institoot pribo-rostroyeniya*), aka NPO Vega-M, under General Designer V. P. Ivanov. The same house was responsible for the Tu-126's Liana (Creeper; NATO *Flat Jack*) radar. A. K. Konstantinov supervised the integration and debugging effort at the Beriyev OKB.

The A-50's main recognition feature is, of course, the conventionally located 'saucer' rotodome of the Shmel' radar mounted on two pylons immediately aft of the wings. It has a 9-m (29 ft 6 in) diameter and is some 2 m (6 ft 6¾ in) deep. The rotodome is mounted more than one diameter ahead of and well below the stabilisers. There have been speculations that lift generated by the rotodome increases downwash on the stabilisers, reducing their efficiency, but the rotodome itself contributes a stabilising influence. Also, wake turbulence from the rotodome reduces the efficiency of the vertical tail but the rotodome pylons make up for this – albeit at the expense of reduced lateral stability because of the additional sideforce above the CG. Anyway, the fact that the A-50 has entered quantity production shows that the arrangement works satisfactorily.

The extensive navigator's glazing has been replaced by a large curved dielectric panel, leaving only a single small window on each side; the A-50 is obviously not the best aircraft for a navigator prone to claustrophobia! These windows and the two rearmost flightdeck windows on each side have gold plating to protect the crew from radiation. The said dielectric panel features four tooth-like projections at the bottom. The weather radar's radome is slightly smaller and has a reshaped joint line with the fuselage, with two small dielectric panels on either side aft of it.

The port entry door is deleted; so is the gunner's station, which is replaced by an avionics bay with two aft-facing antennas covered by large fairings where the tail turret and the glazing used to be. A large cooling air intake is provided at the base of the fin. The cargo ramp is retained but is non-functional, and the cargo doors are deleted. The main gear fairings have constant cross-section almost throughout; the blunt forward portions incorporate two circular air intakes of unequal size. The APU is relocated to the rear portion of the port fairing, with an 'elephant's ear' intake and a downward-angled exhaust (the arrangement was borrowed for the IL-76PP and IL-80).

The A-50 bristles with various antennas. Four ECM antennas in large teardrop fairings are located on the forward and aft fuselage sides; a large dielectric fairing ahead of the wing torsion box covers satellite communications and navigation antennas. Numerous blade aerials are located dorsally and ventrally on the forward fuselage and ahead of the cargo ramp, and two large strake aerials are fitted aft of the nose gear. Chaff/flare dispensers are incorporated into the rear fuselage flush with the skin.

Like its predecessor (the Tu-126), the A-50 has flight refuelling capability – in theory at least. A telescopic refuelling probe is located ahead of the flightdeck glazing, with an external fuel conduit running along the starboard side above the entry door to the wings. For night refuelling the probe is illuminated by retractable lights, a standard feature on Soviet heavy aircraft using the probe-and-drogue system.

Western intelligence got wind of the A-50's development in 1983 and the aircraft was allocated the unusually laudatory reporting name *Mainstay*. At first, however, the West had a rather vague idea of what the aircraft looked like; artist's impressions showed a conventional glazed nose and tail gunner's station, and there have been claims that the fuselage was stretched ahead of the wings (which is clearly not the case). An early drawing even showed the rotodome mounted on a single short pylon in the manner of the Tu-126.

Several A-50 prototypes converted from *Candid-Bs*, including '10 Red' (ex-IL-76 *sans suffixe* CCCP-76641, c/n 073409243, f/n 0701) and '20 Red' (c/n 0013430875, f/n 2209A), were involved in the test programme. These had minor detail differences; for instance, '10 Red' and '15 Red' (possibly c/n 073410311, f/n 0808) had standard *Candid*-style tapered aft portions of the main gear fairings. A further uncoded aircraft lacked the 'teeth' and ECM blisters but had the definitive gear fairings. To improve longitudinal stability two large strakes of quasi-triangular planform were added to the aft portions of the main gear fairings on later prototypes and production *Mainstays*. The rearmost portions of the strakes are attached to the cargo ramp and the APU nozzle is located beneath the port strake.

Test flights showed that aerial refuelling was all but impossible because the rotodome would hit wake turbulence from the tanker, causing severe buffeting. On internal fuel the A-50 has an endurance of four hours at 1,000 km (620-mile) from base; MTOW is 190 tons (418,875 lb).

Production apparently began in 1981, with deliveries to the PVO commencing in 1984. Initially the type was operated from a base near Siauliai in Lithuania which had earlier been home to the Tu-126. However, this soon had to be vacated for political reasons and the *Mainstays* moved north to Beryozovka AB near Pechora on the Kola peninsula, which the crews were very unhappy about. The first three years of service were more of an evaluation period and flights were confined to Soviet territory. In fact, the first actual sighting by a Western combat aircraft over international waters did not take place until 4th December 1987 when a Royal Norwegian Air Force (333 Sqn) P-3B Orion from Bodö airbase photographed an uncoded A-50 over the Barents Sea.

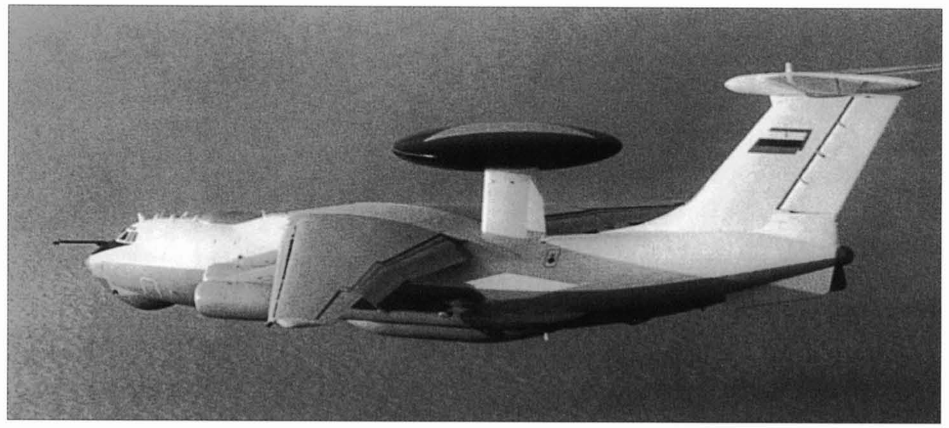
A-50s were also detached to the Far East Defence District (DD) and to the Crimea peninsula, operating from Black Sea Fleet airbases and checking on the Soviet Union's southern borders in practice missions. During Operation Desert Storm in 1990 two *Mainstays* continuously monitored the operations of Iraqi and Allied forces, keeping a watch for stray US cruise missiles which might be heading towards CIS territory. Several aircraft were based at Ukurey, an IL-76 base; in 1999, however, all operational *Mainstays* were concentrated at Ivanovo-Severnyy AB.

Production proceeded at a rate of one to five aircraft a year until 1991. About 25 were believed to be operational in 1992 (this figure includes the later A-50M described below).

In a typical mission the A-50 loiters at about 10,000 m (32,810 ft) on a figure-eight course with 100 km (62 miles) between the centres of the two orbits. The surveillance radar can track targets over land and water and detect surface ships as well as aerial targets. V. P. Ivanov claimed the Shmel' has shorter detection range but better resistance

Yefim Gordon archive

A-50M '51 Red' (c/n 1003488634, f/n 6609) takes off, showing this version's characteristic strap-on chaff/flare dispensers above the horizontal stabilising strakes. Other identification features are the additional antenna blisters just aft of the strakes and the matt white sectors around the ECM blisters.



TANTK Beriyev

Above: The 'green' A-50I during an early post-conversion test flight, with the registration RA-78740 yet to be applied. This view shows well the new design of the 'unrotodome' (which does not rotate at all!).

to ground clutter than the Westinghouse AN/APY-1 fitted to the Boeing E-3A AWACS.

The colour CRT radar displays show targets marked as 'friendly', 'identity unknown' or 'hostile'; 'friendly' aircraft blips are accompanied by the aircraft's tactical code or callsign and information on speed, altitude, heading and fuel status. The *Mainstay* has a crew of fifteen: two pilots, flight engineer, navigator, radio operator and ten mission equipment operators (radar intercept officers, ECM operators and comms officers).

The A-50 usually works with MiG-31 *Foxhound* interceptors, though the MiG-31's powerful Phazotron SBI-16 *Za**slon*** (Shield) phased-array pulse-Doppler radar enables it to act as a 'mini-AWACS' in its own right. Target data are transmitted to the interceptors automatically via data link or by secure voice link. Transmission range to ground C^{3}I centres is 350 km (189 nm) in the metre and decimetre wavebands and 2,000 km (1,081 nm) in the UHF range; SATCOM equipment is used over longer distances.

Pilots are quick to give nicknames to aircraft – affectionate or otherwise. The A-50 was dubbed *shesti**krylyy** sera**fim*** (six-winged seraph, a quotation from Aleksandr S. Pushkin's poem *The Prophet*), alluding both to the numerous aerodynamic surfaces and the 'eye in the sky' role. Yet the *Mainstay* could easily have earned some disparaging nickname, and with good reason. For one thing, the mission avionics were rather troublesome at first. As a result, the equipment often had to be switched from automatic to manual mode a dozen times in a mission. Besides, getting the equipment in was a bit of a squeeze and there was no room left for a toilet and a galley (no small thing on a four-hour mission), to say nothing of room to walk around and stretch one's legs.

Ilyushin/Beriyev A-50M (A-50U?) *Mainstay-B* AWACS

Ilyushin, Beriyev and NPO Vega-M kept working on improving the *Mainstay* – primarily improving reliability and reducing avionics weight. (Soviet avionics weigh about half as much again as their Western counterparts, hence the old joke about Soviet microchips being the largest microchips in the world.) The A-50M equipped with the Shmel'-2 avionics suite was brought out in 1989; among other things, this has an enemy ECM detection and tracking capability. This version has also been referred to as A-50U (*oosover**shen**stvovannyy* – improved or upgraded); however, this may actually be a separate, third version.

External recognition features are the lack of the navigator's station port side window, an additional small blister fairing on each side of the lower aft fuselage near the cargo ramp and additional strap-on 96-round chaff/flare dispensers. These are of a different type than used hitherto on the IL-76MD, being much narrower.

The A-50M prototype was apparently coded '44 Red' (c/n 0093486579, f/n 6505). Other confirmed examples are '50 Red' and '51 Red', though '52 Red' and '53 Red' are probably 'Ms as well. '51 Red' was in the static park at MosAeroShow '92, making the *Mainstay's* public debut, and at MAKS'93. Escorted by four Su-27 *Flanker-B* fighters from the PVO combat and conversion training centre at Savasleyka AB near Nizhniy Novgorod, the same aircraft took part in the military parade in Moscow on 9th May 1995.

As a point of interest, in July 1987 *Air International* published a drawing of the A-50 with triple vertical tails (!), wingtip ECM pods and a conventional glazed nose. However, there is no evidence that such a version ever existed. Indeed, Western magazines sometimes published total science fiction about Soviet aircraft, such as the feature in the October 1978 issue of *International Defence Review* with 'artist's impressions' of AWACS and tanker versions of the IL-86 obtained by retouching photos of the prototype (CCCP-86000).

TANTK Beriyev

Another view of the A-50I flying near Taganrog, showing the aft fuselage strakes and the absence of the fin root air intake.

Ilyushin/Beriyev/Israel Aircraft Industries A-50I ('aircraft AI') AWACS

In 1994 the Chinese People's Liberation Army Air Force (PLAAF) started negotiations with Russia and Western avionics manufacturers on the conversion of the *Candid* into an AWACS platform. GEC-Marconi (UK) offered the Argus 2000 mechanically-scanned AEW radar system fitted earlier to the unsuccessful British Aerospace Nimrod AEW Mk 1, but lost out to Elta Electronics, a division of Israel Aircraft Industries (IAI) which offered a more sophisticated mission avionics suite built around the EL2075 Phalcon phased-array radar. Interestingly, China was adamant that it would only buy the Phalcon system if it was installed on the IL-76.

Originally the radar arrays were to be housed in the nose, the tailcone and on the forward fuselage sides in similar fashion to IAI's Boeing 707-320 AWACS equipped with the Phalcon radar (as delivered to the Chilean Air Force). However, this was soon abandoned in favour of a conventionally mounted rotodome. The resulting combination is known as A-50I or *izdeliye* AI, the I standing for *iz**rail**'skoye* [*obo**roo**dovaniye*] – Israeli equipment.

It took a lot of persuasion before the Russian government gave the go-ahead for the A-50 to be exported. Some sources suggest the Russian government was reluctant to allow a *Mainstay* to be sold to IAI for conversion because it had hoped to sell the A-50 to China in an 'as-was' condition.

Outwardly the A-50I differs from the basic *Mainstay* it a number of respects. The rotodome is slightly larger in diameter and the pylons are of constant chord (that is, do not taper towards the top). Also, the rotodome has a much wider metal centre portion and three dielectric portions instead of two; the 'rotodome' is in fact fixed and the radar beams are scanned electronically. An official Beriyev display model unveiled in January 2000 shows that the metal centre portion is an equilateral triangle with cropped apexes (that is, there are three antenna arrays, each covering a sector of 120°). The model also shows non-standard extended and rounded wingtips probably housing ESM antennas.

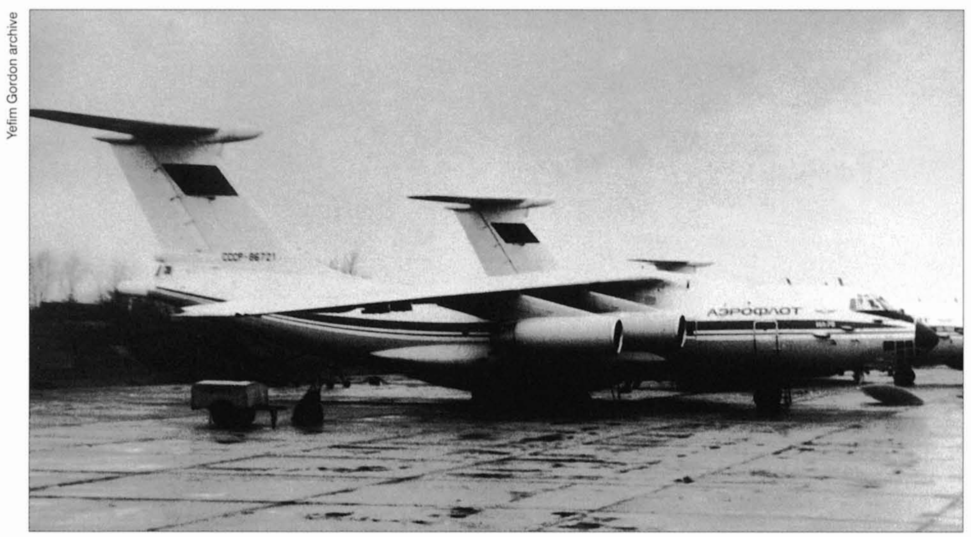
The triangular horizontal strakes characteristic of the standard A-50 have been deleted. Instead, the A-50I has twin splayed trapezoidal ventral fins in the manner of the Iraqi Adnan-1 and -2 conversions (see below); however, these are rather shorter and deeper and have rounded corners. The large cooling air intake at the base of the fin, another trademark feature of the standard *Mainstay*, is also omitted, as are the dielectric panel immediately below the rudder and the large ECM blisters on the forward and aft fuselage sides. On the other hand, the A-50I has an unswept blade aerial atop the fin about level with the stabiliser leading edge (which Russian Air Force aircraft do not have) and a single unswept blade aerial immediately ahead of the dorsal SATCOM fairing has been replaced with two small swept aerials.

The basic A-50's refuelling probe has been retained. The PLAAF has converted a small number of H-6 (licence-built Tu-16 *Badger-A*) bombers to single-point hose-and-drogue tankers, the local equivalent of the Tu-16N, and these will probably be used to support the operations of the A-50I.

Wearing a standard *Mainstay* grey/white colour scheme and the test and delivery registration RA-78740 (!), the A-50I prototype (ex-Russian Air Force '44 Red', c/n 0093486579, f/n 6505) was delivered to Tel Aviv (Ben Gurion airport) for conversion on 25th October 1999 after several months of delays. The cost of outfitting a single aircraft to A-50I standard (not counting the aircraft itself) was estimated at some US$ 250 million. However, despite being on reasonably good terms with mainland China, the USA saw the deal as a threat to Taiwan (which

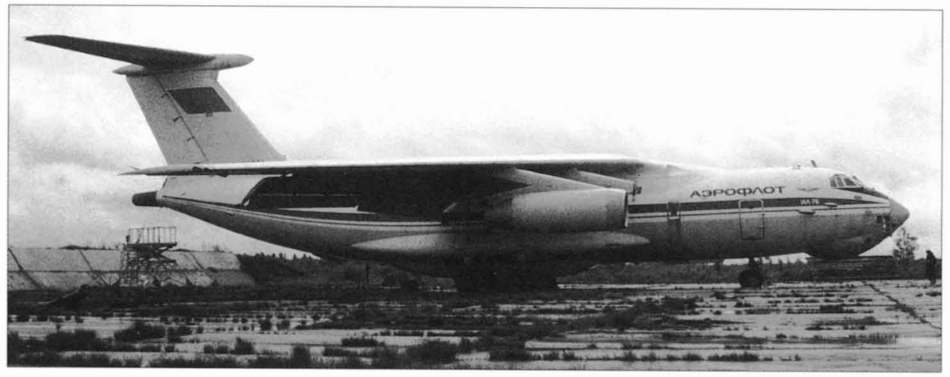
Viktor Drushlyakov

Above: 'Aircraft 776' (CCCP-86024) comes in to land at Zhukovskiy, showing the rear thimble radome.



Yefim Gordon archive

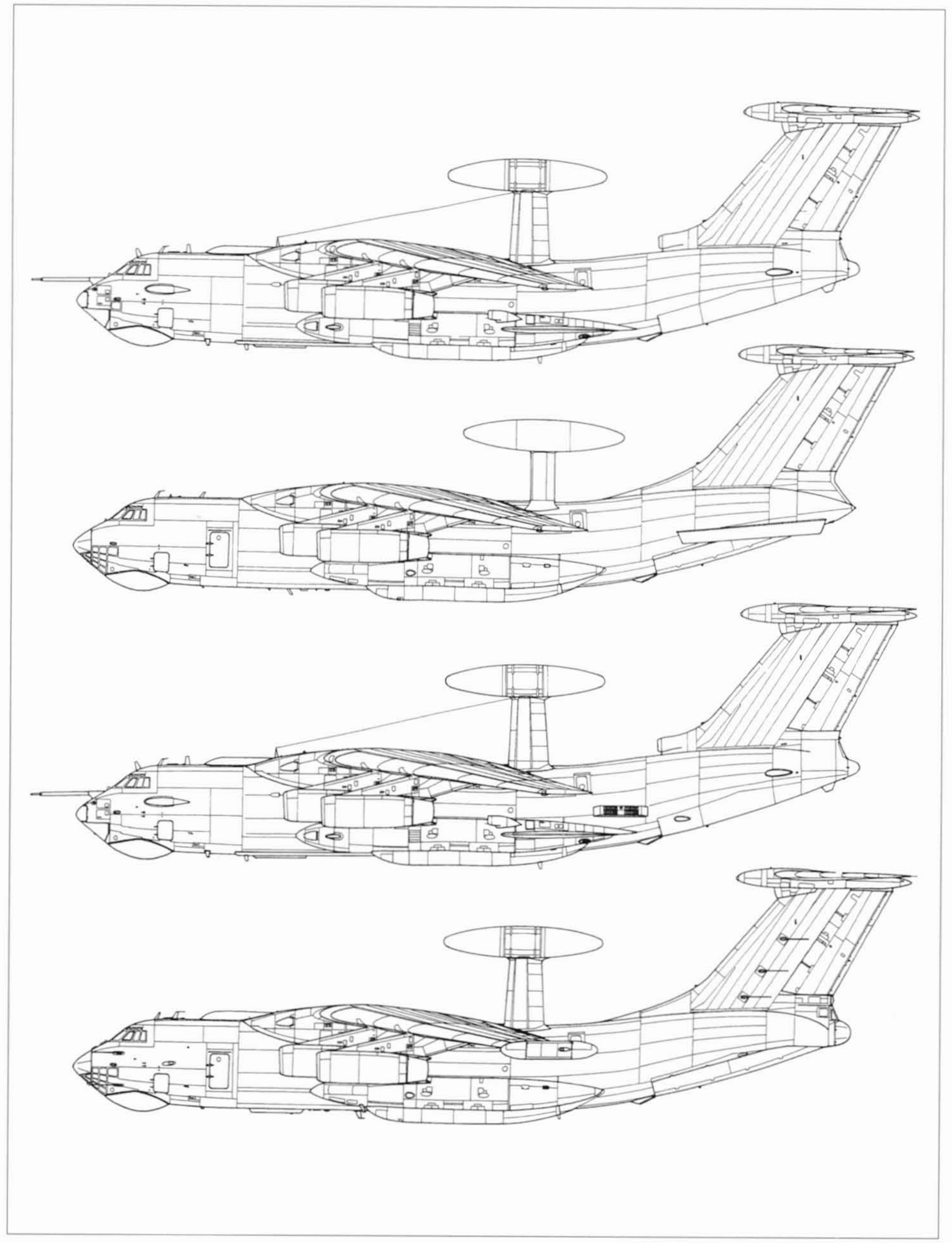
An interesting shot of 'aircraft 676' (CCCP-86721) and 'aircraft '776' parked at Zhukovskiy; note that 'aircraft 676' retains the ECM blisters on the forward fuselage. The chin radome is removed from maintenance.



Sergey Skrynnikov

Above: 'Aircraft 676' languishes at the Staraya Roossa aircraft overhaul plant, with few prospects of flying again.

Beijing purportedly still aims to recapture by force) and began putting pressure on Israel, trying to stop the deal from coming through. Israel put on a show of defiance at first (Prime Minister Ehud Barak said IAI will fulfil its contract obligations no matter what) but gave in when the USA threatened to withdraw US$ 20 billion worth of military aid. Recently, however, India has signed an order for a similar conversion of three IL-76MDs.



Andrey Yurgenson

Top to bottom: The A-50 *sans suffixe* AWACS; the Baghdad-2 (Adnan-1)/Adnan-2 AWACS conversion; the A-50M AWACS; the 'aircraft 976' radar picket/telemetry relay aircraft.

Ilyushin/Beriyev A-50E *Mainstay* AWACS

This is the export version of the A-50 (E = ***eks**portnyy*) probably differing from the standard *Mainstay* in avionics fit. China is the 'launch customer' following the demise of the A-50I programme.

Ilyushin/Beriyev 'Aircraft 676', 'Aircraft 776' development aircraft; 'Aircraft 976' (IL-76SK) *Mainstay-C* radar picket aircraft

Monitoring and recording systems operation during test launches of ballistic and cruise missiles is something of a problem, since conventional data recorders are highly unlikely to be retrieved intact when the missile drops – or blows up in mid-air. As one Russian author put it, the wreckage can then tell no more about the cause of the accident than the ashes of a burnt book can tell about its contents. The only reliable method is to transmit systems data by means of telemetry which is picked up by ground measuring stations or specially equipped aircraft.

For years LII had used the IL-18SIP (CCCP-27220) described earlier in this chapter. This aircraft with its characteristic huge dorsal canoe fairing and 'thimble' tail radome over data link antennas, was the prototype of the new-build IL-20RT space tracker/ telemetry and communications relay aircraft, four of which (CCCP-75480 through CCCP-75483) were used in the Soviet space programme. However, in due course the IL-18SIP had to be retired, forcing LII to find a replacement.

First, two *Candid-Bs* – IL-76 *sans suffixe* CCCP-86721 (c/n 073410271, f/n 0708) and IL-76M CCCP-86024 (c/n 083414425, f/n 1107) – were converted into almost identical telemetry pick-up aircraft known as 'aircraft 676' and 'aircraft 776' respectively. These shared some of the equipment with the IL-18SIP and IL-20RT, including the rear antenna in a characteristic thimble radome (supplanting the tail turret on the *Candids*). An L-shaped aerial was mounted on each side of the fin; this caused the Soviet flag to be painted unusually high on the fin. Four long probes were fitted around the navigator's station, and two large strake aerials were mounted aft of the nose gear, as on the A-50. The ECM suite was originally retained. Later CCCP-86721 had the probes removed and the navigator's glazing partly faired over; also, the tail radome, originally white on both aircraft, later became dark grey on 'aircraft 676'.

Operational experience with 'aircraft 676' and 'aircraft 776' led to the development of a specialised radar picket version of the IL-76MD designated 'aircraft 976' or SKIP (*samo**lyot**nyy ko**mahnd**no-izme**rite**l'-nyy poonkt* – airborne measuring and control station, AMCS). The unusual designation is probably derived from the aircraft's product code which could be *izdeliye* 976. Development was completed in the mid-80s; the aircraft was developed jointly with the Beriyev OKB and hence has been erroneously referred to in the West as 'Be-976' (some sources call it 'Myasishchev-976').

'Aircraft 976' is superficially similar to the A-50 AWACS, featuring an identical rotodome – which, incidentally, has earned it the nickname ***Pogahn**ka* (Toadstool) at LII. Like the A-50, it has satellite communications and data link antennas in a large dielectric fairing ahead of the wings and two strake aerials aft of the nose gear.

But here the similarity ends. The AMCS retains the standard navigator's glazing, the tail gunner's station (used as an equipment operator's station), the cargo doors and both entry doors. The main gear fairings and APU location are likewise unchanged from the IL-76MD, and the A-50's characteristic horizontal strakes have been omitted. This is probably because the equipment installed in the freight hold and rotodome is different; hence the weight distribution is also different and the rotodome does not have such a drastic effect on the aircraft's longitudinal stability.

The tail turret is replaced by a hemispherical radome which is more bulbous

Viktor Drushlyakov

Viktor Drushlyakov

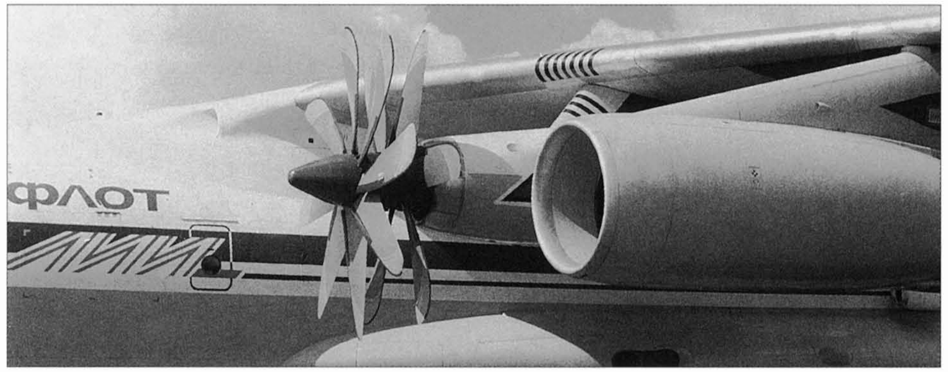
Top and above: 'Aircraft 976' CCCP-76452, the first of five, displays its recognition features, making an interesting comparison with the A-50. Small wonder it has been mistaken for an A-50 prototype!

Gromov Flight Research Institute

CCCP-76456, the last 'aircraft 976', parked at the end of the old runway at Zhukovskiy which is now used as a parking area.

Gromov Flight Research Institute

Above: IL-76LL CCCP-76529 (aka IL-76LL4, c/n 073410308, f/n 0807) in its original configuration with a Lotarev D-236T propfan in the No.2 position.



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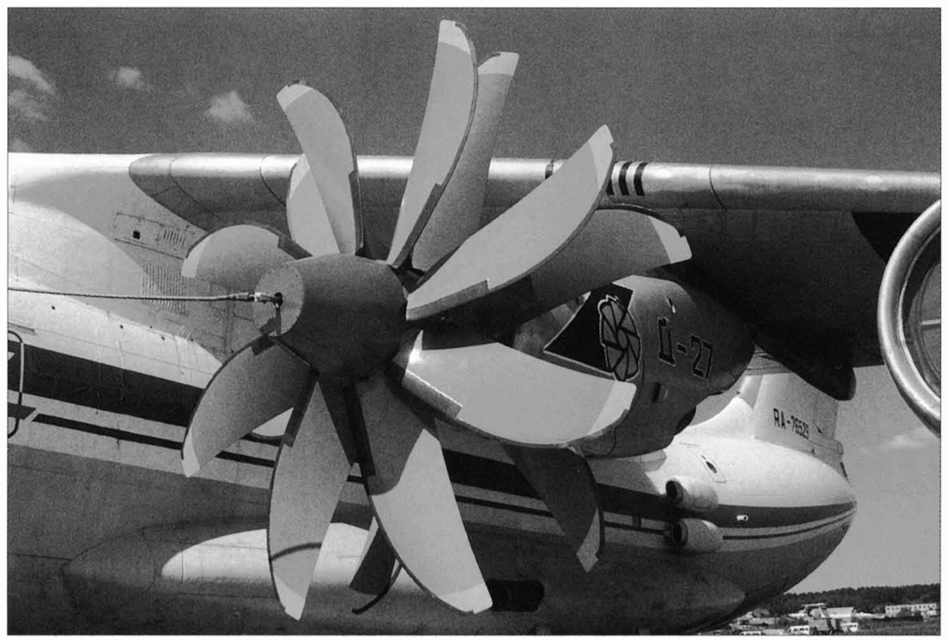
Above: Close-up of the D-236T development engine driving SV-36 contra-rotating propellers. Note the icing detection stripes on the No.2 engine pylon and wing leading edge and the large Cyrillic 'LII' titles on the cheatline.



Dmitriy Komissarov

The same aircraft (now registered RA-76529) in its second configuration with a Muravchenko D-27 development engine and SV-27 propellers. Note the test equipment heat exchangers and the video camera further aft; the cable connected to the propeller hub serves a vibration sensor.

than the rear fairing of demilitarised *Candid-Bs*, and the gun ranging radar is deleted. Two massive cylindrical equipment pods similar to those of the IL-76PP are carried on the wingtips. Their front and rear portions are dielectric, enclosing flat-plate antennas.

As on 'aircraft 676' and 'aircraft 776', four long probes are located around the navigator's station. The fin has three L-shaped aerials on each side instead of one. Four L-shaped aerials of a different type are mounted ahead of the flightdeck glazing, the inner ones facing forward and the outer ones aft; several blade aerials are fitted under the main gear fairings. The freight hold is crammed with data processing and storage equipment which appears to be modular, allowing the aircraft to be reconfigured for specific missions (part of it is mounted on the cargo ramp on some aircraft).

Five new IL-76MDs built in 1986-87 were converted to 'aircraft 976' standard. Despite their near-military role they wore Aeroflot colours and were registered CCCP-76452 (c/n 0063465965, f/n 5002), CCCP-76453 (c/n 0063466995, f/n 5009), CCCP-76454 (c/n 0063469074, f/n 5209), CCCP-76455 (c/n 0063471125, f/n 5402) and CCCP-76456 (c/n 0073474208, f/n 5602); three out of five aircraft still have the old Soviet prefix and flag as of this writing. The only deviation from the standard Aeroflot colour scheme is that the nose titles read '976' instead of 'IL-76MD' and the flag is carried higher on the tail than usual.

The aircraft differ in detail. For example, at least two aircraft (CCCP-76452 and -76453) have an orange-painted cylindrical fairing of unknown purpose protruding downwards immediately ahead of the cargo ramp. CCCP-76452 also has L-shaped aerials mounted above and below the wingtip pods.

The AMCS is used to monitor the trajectories and systems status of manned and unmanned aerial and space vehicles in real time. UAVs can be remote-controlled; a self-destruct command can be transmitted if an experimental missile goes haywire and heads where it shouldn't. Telemetry data is processed, taped and transmitted in real time to build ground control and telemetry processing centres by radio or satellite link, thus obviating the need to build additional facilities in remote areas. Tracking range is 1,000 km (540 nm) and trajectories are measured with an accuracy of 30 m (100 ft). The six telemetry channels have a data transfer rate of 2 million baud (2 Mb per second). Endurance is 8 hours.

The existence of 'aircraft 976' was revealed on 16th August 1988 during the Aviation Day flypast in Zhukovskiy. Spectators sitting on vantage points near LII's perimeter fence could see all five aircraft parked in a neat row at the end of the old runway where it joined the active 5,000-m (16,400-ft) runway. The A-50, as already mentioned, had been sighted in late 1987, and of course Western journalists believed the 'toadstools' to be prototypes of the A-50 (what else could they think?); it was some time before the matter was clarified. Nevertheless, 'aircraft 976' now has the reporting name *Mainstay-C*!

Of course the Powers That Be were aware that there was no point in concealing the existence of the AMCS any longer. Hence LII's display stand at the Moscow Aerospace '90 trade fair held at the VDNKh fairground in October 1990 featured a photo of 'aircraft 976'. On 23rd May 1991 the *Soviet Weekly* gazette ran a story about LII titled *Secret Centre of Excellence* and featuring, among other things, a photo of CCCP-76453. The caption read: *'The Ilyushin-76 flying laboratory, used to study the chemical composition of the atmosphere'*. This was nonsense, of course, as the rotodome obviously had nothing to do with 'studying the chemical composition of the atmosphere'!

A year later the same aircraft was in the static display at MosAeroShow '92 – this time with a tablet truthfully saying 'airborne measuring and control station' but containing no data whatever. CCCP-76456 was displayed next year at MAKS-93 and for the first time visitors were allowed inside the thing but, understandably enough, photography was out of the question. RA-76453 was present again at MAKS-95 (so far it is the only 'aircraft 976' to have the Russian prefix and the LII logo), and CCCP-76452 was on display at MAKS-97.

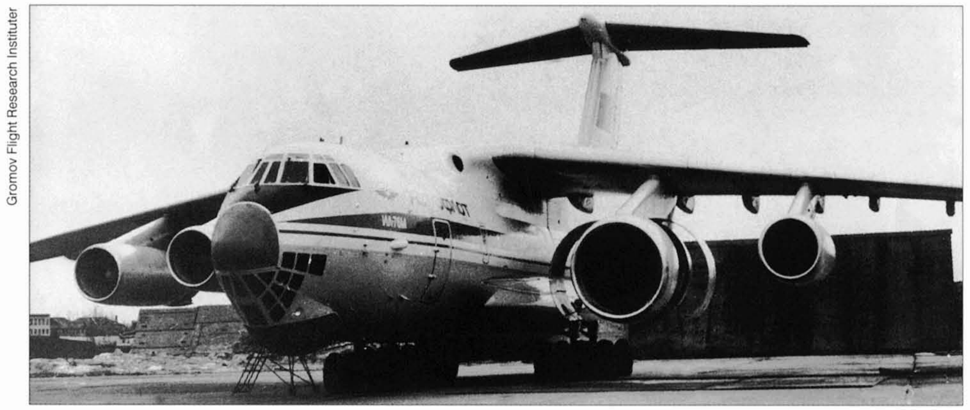
Curiously, a model of RA-76453 displayed at MAKS-95 showed 'IL-76SK' (*spetsi**ahl'**nyy ko**mahnd**nyy* [*samo**lyot***] – special command aircraft) nose titles. This is a proposed development of 'aircraft 976' to be used for monitoring launches of the Burlak suborbital launcher carried by the Tu-160SK; there are reasons to believe the IL-76SK differs in equipment fit from the other 'toadstools'. The same model was also displayed at Farnborough International '96.

'Aircraft 976' are known to have been used in the Tu-160's trials programme, monitoring test launches of RKV-500 (Kh-55M)/AS-15 Kent cruise missiles. LII claims the AMCS may also be used for ecological monitoring 'and other purposes' (sic).

Izdeliye 1076

There have been reports of an unidentified special mission version of the IL-76 designated izdeliye 1076. No information is available except that the prototype is c/n 1033410351 (f/n 8408).

The IL-76 has been extensively used for testing new equipment, civil as well as military. Of course it cannot beat such testbed workhorses as the IL-18 or An-12 in terms of numbers. Still, the the *Candid's* good performance and spacious freight hold which can accommodate lots of bulky and heavy test equipment (and is pressurised – a major advantage over the An-12!) make it eminently suitable for the testbed role. Known aircraft are listed below.



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Above: IL-76LL CCCP-86891 (c/n 093421628, f/n 1607A). The huge size of the Lotarev D-18T development engine is obvious.

IL-76LL engine testbed

The IL-76LL engine testbed is perhaps the best-known of the R&D *Candids* – probably because it was used to test mainly 'civilian' engines and thus could be demonstrated publicly without causing a security breach. As already noted, the LL suffix meaning *le**ta**yuschchaya labora**to**riya* can denote any kind of testbed or research aircraft. In the case of the IL-76, however, the LL suffix applies strictly to the engine testbed.

Development of the IL-76LL began in the late 1970s when LII was faced with the need to test new powerful jet and turboprop engines. Previously converted bombers (for example, Tu-4LL, Tu-16LL and Tu-142LL, each of which existed in several examples) had filled this role, but they had a major deficiency, namely limited space for test equipment.

The experimental engine is fitted on a special pylon instead of the No.2 (port inboard) D-30KP. The pylon has special fittings enabling different engines to be installed quickly; hence the aircraft has also been referred to as ULL-76 or ULL-76-02 (*ooniver**sahl'**naya le**ta**yuschchaya labora**to**riya* – multi-purpose testbed). The main shortcoming of this installation is that the experimental engine can create a thrust asymmetry which has to be countered by differential thrust of the other engines and/or control input.

The IL-76LL can be used to test engines rated at up to 25,000 kgp (55,110 lbst) and having a nacelle diameter up to 3.56 m (11 ft 8⅛ in). Since the experimental engine can be both heavier and more powerful than the D-30KP, the wing centre section and No.2 pylon attachment points have been reinforced.

The freight hold houses five test engineer workstations and two equipment modules for recording and monitoring engine parameters. The modules can be changed to suit the mission; part of the equipment (for example, video recorders) is of Western origin. Test equipment heat exchangers, a characteristic feature of the IL-76LL, are installed on the fuselage sides immediately aft of the wings; their quantity differs on different examples. The electrical system has been modified to supply 208 V/115 V/36 V (400 Hz) AC, 220 V/127 V (50 Hz) AC and 27 V/6 V DC for the test equipment.

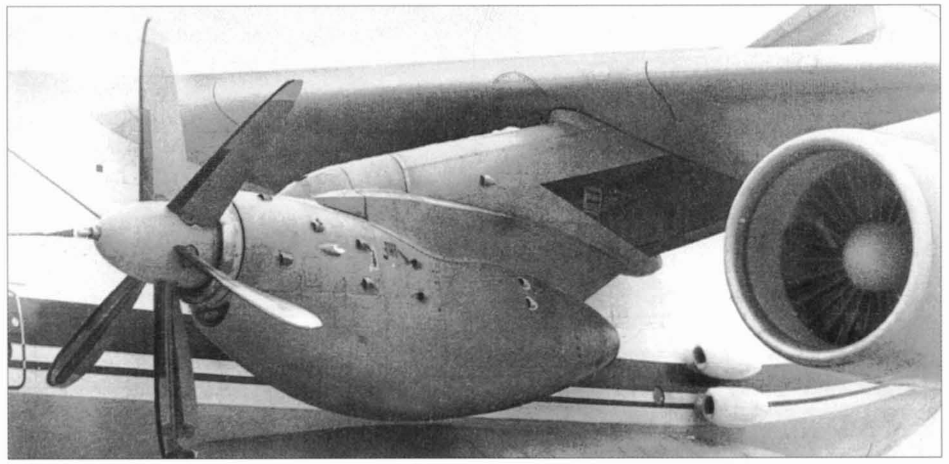
Five *Candids* were converted to IL-76LLs (a sixth aircraft, IL-76T 'Falsie' CCCP-76528 (c/n 073410293, f/n 0804), was set aside for conversion but never converted). The first of these was the first prototype, CCCP-86712 (c/n 0101), which ended its days as a test-

Dmitriy Komissarov

IL-76LL CCCP-76492 (c/n 0043452549, f/n 3908) in the static park at MosAeroShow '92. The PS-90A development engine is carried on a non-standard pylon; the pylons of the IL-76MF are different.

Yefim Gordon

Above: A beautiful air-to-air of IL-76LL CCCP-06188 (the IL-76LL5; c/n 093421635, f/n 1609) with the TV7-117A development engine running. Note the 'IL-76T' nose titles and the tail gunner's station.

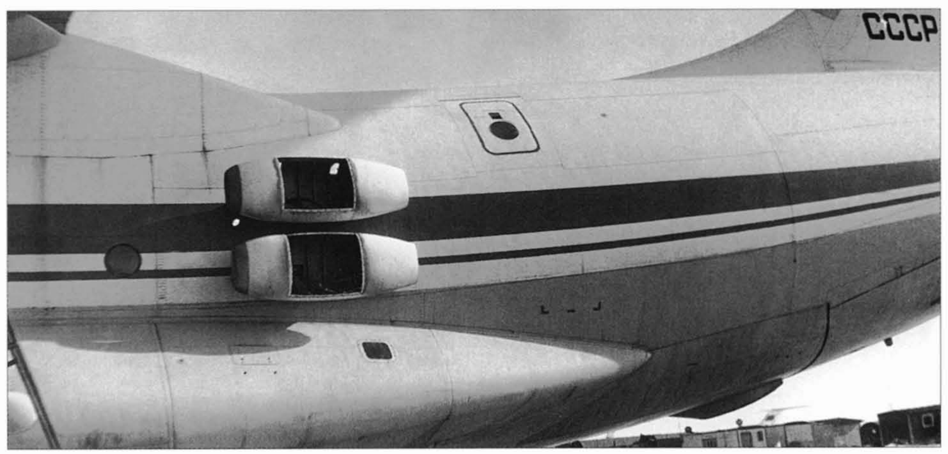


Yefim Gordon archive

Above: Close-up of the TV7-117A engine and feathered SV-34 propeller; the many small air intakes were featured on this trials installation only. Note the vibration sensor cable.

bed for the Kuznetsov NK-86 turbofan – curiously, minus thrust reverser. Tests began in 1975. By then CCCP-86712 had reached the limit of its useful life and the aircraft was scrapped once the trials programme had been completed in the late 1970s.

The second aircraft, IL-76M 'Falsie' CCCP-86891 (c/n 093421628, f/n 1607A), originally reported as ex-YI-AKV, was used to test the 23,400-kgp (51,590-lbst) Lotarev D-18T high-bypass turbofan. This engine was developed for the An-124 heavy transport by ZMKB (*Zaporozhskoye motornokonstrooktorskoye byuro 'Progress'* – 'Progress' Zaporozh'ye Engine Design Bureau) and had nearly twice the diameter of the D-30KP. One test equipment heat exchanger was fitted to port and two to starboard. A small cigar-shaped fairing of unknown purpose was mounted on a short pylon above the flightdeck.



Yefim Gordon

This photo shows how the IL-76LL's heat exchanger fairings look with the heat exchangers removed.

Tests began in 1982 and the engine logged 1,285 hours in 418 test flights. Black and white stripes were applied to the intake de-icer for icing visualisation and a video camera was fitted in place of the wing/air intake inspection light at a late stage of the trials. Reregistered RA-86891, the aircraft was in the static park at the MAKS-95 airshow.

The Kuznetsov NK-93 contra-rotating integrated shrouded propfan (CRISP) rated at 18,000 kgp (39,680 lbst) was the next candidate for testing aboard CCCP-86891. The engine, which had eight scimitar-shaped blades on the front row and ten on the rear row, was envisaged for several projects, all of which remain 'paper airplanes' – the IL-90-200 long-haul widebody airliner, the IL-106 heavy transport, the Myasishchev MGS-6 (MGS = *mnogotsele**voy** groozovoy samo**lyot*** – multi-role cargo aircraft, aka M-90 Flying Ferry) horrendously heavy transport and the Tu-214 (the first Tu-204 derivative to have this designation; the later real Tu-214 was powered by PS-90A engines).

Five prototype engines had been completed by 1995 but the trials were postponed indefinitely because the Kuznetsov OKB (now known as MKB 'Trood', the 'Labour' Engine Design Bureau) could not afford to pay for them. Meanwhile, RA-86891 was retired and was being broken up at LII in August 1999.

As for the D-18T, ZMKB has developed growth versions intended for the An-218 widebody airliner – the 25,000-kgp D-18TM and the 27,500-kgp (60,630-lbst) D-18TP/D-18TR. However, these are too large for the IL-76LL and will have to be tested on a suitably modified An-124.

The third IL-76LL (sometimes called IL-76LL3) is an IL-76MD 'Falsie' registered CCCP-76492 (c/n 0043452549, f/n 3908) – the first aircraft to have this registration (it was reused on another IL-76 later). The aircraft was used to test the Solov'yov D-90 (PS-90A) turbofan and has two heat exchangers on each side (a late addition). Testing began on 26th December 1986 and the prototype engine logged about 400 hours in 188 flights. It transpired that cruise SFC was better than anticipated but the engine was delivering less power than it should. This was proved by the Tu-204's poor single-engine performance and led the Solov'yov OKB to uprate the PS-90A, whereupon reliability problems began.

Other versions of the PS-90 family were developed in the early 1990s, including the PS-90P (a joint effort with Pratt & Whitney, MTU and MAN) and the derated 12,000-kgp (26,455-lbst) PS-90A-12 for the Yakovlev Yak-242 airliner project. These would probably have been tested on the same IL-76LL but the collapse of the Soviet Union and ensuing economic problems meant trials had to be put on hold. CCCP-76492 was on display at MosAeroShow '92 and visitors were even allowed inside the aircraft. Currently CCCP-76492 is in storage at LII.

The fourth and perhaps best-known example (IL-76LL4) is a demilitarised IL-76 *sans suffixe*, CCCP-76529 (ex-YI-AIP, c/n 073410308, f/n 0807). Initially this aircraft was fitted with the first Soviet propfan engine – the 10,900-ehp (8,128-ekW) Lotarev D-236T driving SV-36 contraprops developed by the Stoopino Machinery Design Bureau. The engine was a derivative of the D-136 turboshaft powering the Mi-26 *Halo* heavy transport helicopter. This in turn was based on the core of the 6,500-kgp (14,330-lbst) D-36 turbofan powering the An-72/An-74 *Coaler* STOL transport and Yak-42 *Clobber* short/medium-haul airliner.

Propfan airliner projects, which were many in the late 1980s, invariably had the engines in pusher configuration. The D-236T, however, had tractor propellers, being intended for the An-70 transport developed since the early 1980s as an An-12 replacement, and thus could be readily installed on the IL-76LL. The SV-36 had glassfibre blades with a hollow composite spar and integrated electric de-icing threads. The front and rear rows had eight and six blades respectively, running at 1,100 and 1,000 rpm respectively; the 100-rpm difference was intended to reduce noise and vibration.

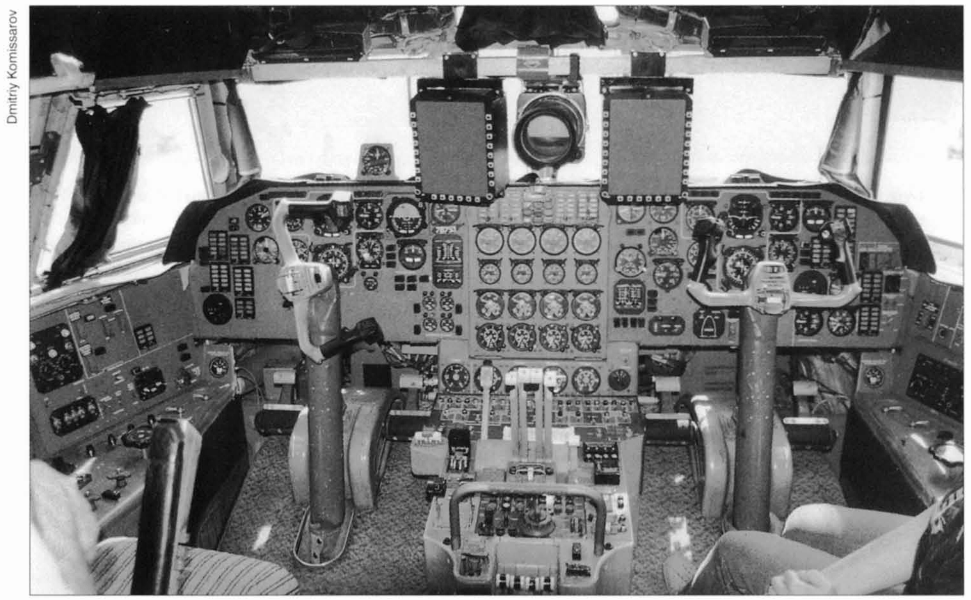
Tests began in 1987. A model of the IL-76LL with the D-236T propfan and the spurious registration CCCP-86786 was displayed at the 38th Paris Aerospace Salon in June 1989. In August next year the real aircraft showed up at the ILA'90 airshow in Hannover, creating a veritable sensation. It was immediately apparent that the abovementioned model had been inaccurate: the SV-36 had straight blades with slightly raked tips, not the scimitar-shaped blades of the model. CCCP-76529 took part in the flying display and the engine demonstrated remarkably low noise levels, both on the ground and in flight, thanks to the low propeller speed.

As originally flown the propeller blades were grey with red and yellow calibration markings on the front row, and a vibration sensor cable was stretched between the propeller hub and the fuselage. By the time of the aircraft's Hannover appearance the cable had been removed and two test equipment heat exchanges installed on each side of the fuselage. The propeller blades were painted bright blue with yellow tips; black stripes were applied to the engine pylon and wing leading edge for icing visualisation, and large orange Cyrillic 'LII' titles added to the forward fuselage.

Because of the straight blades, the fairly large propeller diameter (4.2 m/13 ft 9⅜ in) and tractor configuration Western observers were wont to regard the D-236T as an 'advanced turboprop' rather than a pure propfan. In contrast, experimental US propfan engines (General Electric GE36 and Allison Model 378-DX) had pusher propellers of 3-3.5 m (9 ft 10 in to 11 ft 5¾ in) diameter with sharply curved blades.

Dmitriy Komissarov

Above: IL-76MD 'Falsie' RA-76753 (c/n 0073481461, f/n 6206) in the static park at the MAKS-95 airshow; note the SLAR radome ahead of the main landing gear fairing.



Dmitriy Komissarov

Dmitriy Komissarov

Centre and above: The flightdeck and the navigator's station of RA-76753 in further modified form at the MAKS-2003, with multi-function displays developed by Roosskaya Avionika.

Dmitriy Komissarov

Above: The IL-76-11 avionics testbed (RA-76490) sits engineless at Zhukovskiy in August 1993; the ELINT systems fairing is just visible ahead of the starboard main landing gear fairing.

Dmitriy Komissarov

Above: Close-up of the ELINT systems fairing on the IL-76-11, showing the dielectric panels of unequal size.

This was probably because Western propfan airliner projects (Boeing 7J7 and the like) had a T-tail, rear-engine layout with the engines mounted as close to the fuselage as possible to reduce thrust asymmetry in the event of an engine failure. This inevitably resulted in small-diameter props which had to turn at high speed to generate adequate thrust. At 1,300 rpm the blade tips reached almost supersonic speeds, producing a deafening noise, which of course was totally unacceptable; hence scimitar-shaped blades were used to cure the problem.

(Incidentally, the model had misled Western observers in more ways than one. Several reference books, including *JP Air-line-Fleets International,* list the non-existent IL-76LL CCCP-86786 with a Klimov TV7-117 turboprop!)

The D-236T logged 70 hours in 36 flights on the IL-76LL. Further trials were made on the Yak-42LL (Yak-42E) CCCP-42525 (c/n 11030703) which had the propfan installed on a long pylon in place of the No.3 engine – again in tractor configuration. Meanwhile, however, the An-70's MTOW had increased from 93,100 kg (205,250 lb) to 123,000 kg (271,160 lb). The Antonov OKB apparently considered the D-236T too small and by 1990 the project was altered to feature 14,000-ehp (10,290-ekW) Muravchenko (ZMKB) D-27 propfans driving Stoopino SV-27 contraprops of 4.49 m (14 ft 8¾ in) diameter.

In late 1990 a prototype D-27 engine was fitted to IL-76LL CCCP-76529. Outwardly the engine installation was very similar to the D-236T, except that the blades were scimitar-shaped. The engine nacelle was somewhat more streamlined and the oil cooler was recontoured (the result was vaguely reminiscent of the 'Andy Gump' nacelles of the Boeing B-50). Again a vibration sensor cable was fitted to the propeller hub, and a video camera was added aft of the port side heat exchangers to monitor engine operation.

In this guise CCCP-76529 was displayed statically at the MAKS-93 airshow. Next year it participated in the FI'94 and ILA'94 airshows, appropriately reregistered as RA-76529; the sensor cable was removed and a normal spinner installed for the occasion. Meanwhile, the first prototype An-70 was rolled out at Kiev-Svyatoshino on 20th January 1994 and entered flight test on 16th December of that year, becoming the world's first aircraft to fly solely on propfan power. RA-76529 was on show again at MAKS-97.

TANTK Beriyev

The terrifying A-60 laser weapons testbed, CCCP-86879. The bulbous nose and the turbine powerpack fairings are clearly visible.

Finally, the fifth IL-76LL (IL-76LL5) is a demilitarised IL-76T 'Falsie' with the non-standard registration CCCP-06188 (ex-IL-76M YI-AKQ, c/n 093421635, f/n 1609). This aircraft was used to test the Klimov (Sarkisov) TV7-117A turboprop driving an SV-34 six-bladed propeller. The engine was developed for the IL-114 feederliner and originally rated at 2,350 ehp (1,760 ekW). (Production IL-114s are powered by the 2,500-eshp (1,840-kW) TV7-117S). It was also selected for a number of transport aircraft projects, including the IL-112, Mikoyan MiG-101M, MiG-110, MiG SVB and the Sukhoi Su-80 (however, the first prototype of the Su-80 built in late 1999 is powered by General Electric CT7-9B turboprops).

The aircraft has two heat exchangers to port and one to starboard. Unlike all other IL-76LLs, CCCP-06188 retains the standard No.2 engine pylon (the development engine is attached by means of an adapter). The nacelle of the turboprop has an unusual banana-like shape and numerous small cooling air intakes, most of which have been omitted on the IL-114. Once again the propeller was rigged with a vibration sensor cable and had red and yellow calibration markings on the blades.

CCCP-06188 was the first IL-76LL to be demonstrated publicly, taking part in the Aviation Day flypast in Zhukovskiy on 16th August 1990. It also made a single demonstration flight at MosAeroShow '92 (on 12th August, one of the press days).

Starting in 1989, the TV7-117A logged 210 hours in 70 flights on the IL-76LL. By 1995 CCCP-06188 was withdrawn from use and still sits at LII minus the propeller and Nos 1 and 3 engines.

According to a report dating back to 1996 an unspecified example of the IL-76LL was used for testing a prototype D-30KU-90 engine (this upgraded version of the D-30KU, intended for the Tu-154M, was to be produced during overhauls by fitting to it the core from the PS-90A engine).

IL-76MD 'Falsie' navigation system testbed/geophysical survey aircraft

Candids converted into avionics testbeds are less widely known. This is understandable, since these aircraft were mostly used to test military equipment and hence based at airfields which are off limits to nosy spotters.

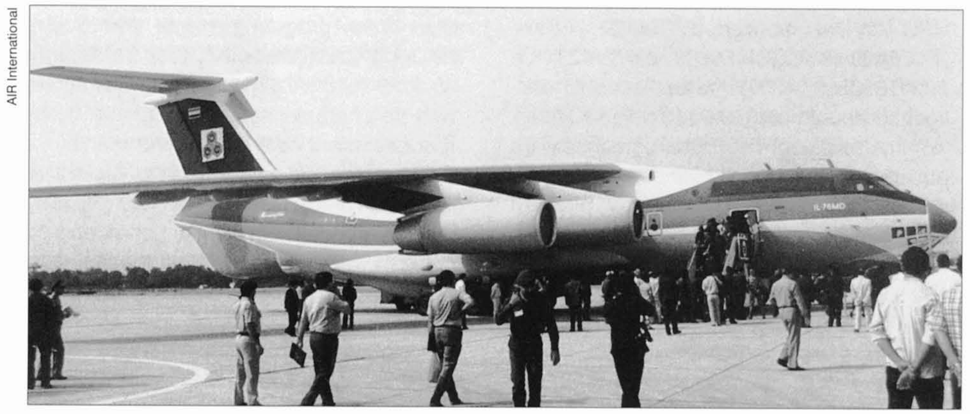
In December 1987 the Moscow-based Fine Instruments Research Institute (NIITP – *Naoochno-issledovatel'skiy institoot tochnykh priborov*) took delivery of a brand-new IL-76MD 'Falsie', CCCP-76753 (c/n 0073481461, f/n 6206), which was immediately converted into a navigation systems testbed. The aircraft is equipped with an IK-VR centimetre-waveband synthetic-aperture side-looking airborne radar (SLAR); the designation is probably deciphered as *izmeritel'nyy* ***kom****pleks* ***v****ysokovo razre****sh****eniya* – high-resolution measurement complex. The SLAR antennas are located on both sides of the fuselage ahead of the main gear fairings in flattened semi-cylindrical fairings which hinge open for maintenance.

Apart from navigation systems testing the aircraft can also be used for geophysical and ecological survey. To this end it is equipped with *Mala****khit*** (Malachite), Poisk (Search) and NP-50 infra-red scanners; their sensors are located in square flat projections atop the wing centre section fairing and under the forward fuselage just aft of the emergency exits. An unswept blade aerial is added just aft of the flightdeck. The conversion job took the better part of a year and the first post-conversion flight took place on 4th October 1988.

The test equipment is located in a compact cubicle in the forward part of the freight hold, leaving the rest of the hold free, so that the aircraft can carry cargo and generate

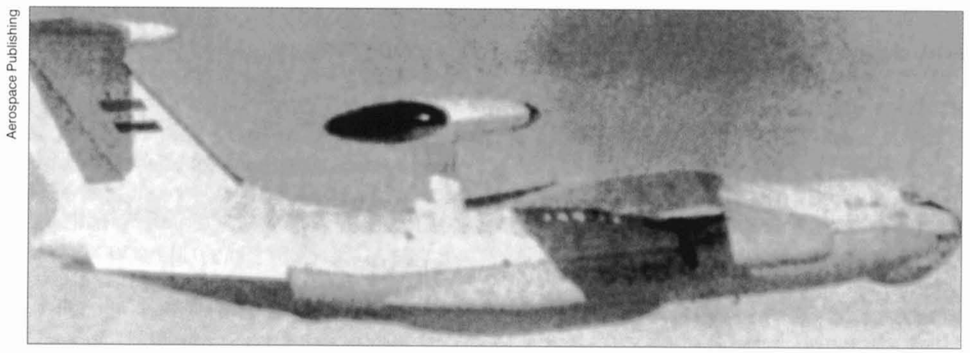
DAZ Press Bureau

Above: The Iraqi Air Force IL-76MD converted into a makeshift tanker with a single Douglas D-704 refuelling pod makes a simulated refuelling of a Mirage F1EQ-200 during a military parade in Baghdad.



AIR International

Above: This Iraqi Air Force IL-76MD 'Falsie' was converted into the one-off 'Baghdad-1' AWACS aircraft with a huge radome supplanting the cargo doors.



Aerospace Publishing

Two further Iraqi Air Force IL-76MD 'Falsies' were converted into the 'Adnan-1' (illustrated here) and 'Adnan-2' AWACS aircraft featuring a conventionally mounted rotodome. Note also the stabilising strakes on the rear fuselage sides.

Volga-Dnepr Airlines

RA-76758 (c/n 0073474203, f/n 5601) of Volga-Dnepr, originally an IL-76TD 'Falsie' and later a 'true' IL-76TD, was earmarked for upgrade to IL-76TD-90 standard but was destroyed by a hurricane before it could be converted.

revenue as well! Reregistered RA-76753, the aircraft was in the static park at the MAKS-95 airshow in Zhukovskiy, its home base.

Later, RA-76753 served for testing new navigation and cockpit data presentation systems developed by the Roosskaya Avionika company and Gos NII AS (Gosoodarstvennyy *na**oo**chno-is**sled**ovatel'skiy insti**toot** aviatsi**on**nykh sis**tem*** – State Research Institute of Aircraft Systems). In this guise it was demonstrated at the MAKS-2003 airshow from 19th to 24th August 2003.

IL-76-11 ELINT testbed

NPO Vzlyot converted IL-76T 'Falsie' RA-76490 (ex-CCCP-76490, ex-YI-AKO, c/n 093416506, f/n 1307) into an electronic intelligence equipment testbed (called IL-76-11 in some sources). The ELINT antennas were housed in a large semi-cylindrical fairing on the starboard side only which blended smoothly into the main gear fairing. The antenna fairing was unpainted and thus plainly visible; it had a cut-off front end to clear the entry door and incorporated three dielectric panels of different size.

The aircraft was first seen at LII in this configuration during MAKS-93. By August 1995 it had been withdrawn from use, sitting engineless at LII, but by August 1999 RA-76490 had been reconverted to standard configuration and returned to service with Elf Air, the flying division of NPO Vzlyot.

IL-76MD/IL-76T 'Falsie' SATCOM testbeds

Two *Candid-Bs* – IL-76MD CCCP-76790 (c/n 0093496903, f/n 7306) and an unidentified IL-76T 'Falsie' – were converted into satellite communications and data link equipment testbeds for the A-50 AWACS. Both aircraft had a large dielectric fairing over SATCOM antennas ahead of the wing centre section; CCCP-76790 was demilitarised. In 1992 both aircraft were sold to the Yekaterinburg-based airline SPAir; the experimental avionics had been removed by then but the dielectric fairing remained.

Ilyushin/Beriyev A-60 airborne laser laboratory ('IL-76 version 1A')

When President Ronald Reagan announced the Strategic Defense Initiative (SDI) supposed to protect the US from Soviet ICBMs, US weapons makers set to work inventing new weapons systems, including laser weapons. Perhaps it was the laser bit that caused the SDI to be nicknamed Star Wars.

One highly unusual aircraft used in the Star Wars programme was the Boeing NKC-135ALL (Airborne Laser Laboratory) 55-3123 (c/n 17239). Photos of this aircraft with its characteristic dorsal canoe fairing and laser turret were sometimes used by the Soviet press for propaganda purposes (to illustrate articles exposing the 'bloody-minded Yankee militarists preparing to unleash war in space'). What these articles did not tell, however, was that the Soviet Union had a similar aircraft up its sleeve.

A photograph of the prototype Kamov Ka-32 *Helix* helicopter (CCCP-31000) made by the TASS news agency at Zhukovskiy showed two of the four IL-80 airborne command posts in the background. Having got hold of this photo in June 1991, *Flight International* perceived the apparent similarity of the Maxdome's SATCOM fairing with the NKC-135ALL's superstructure and raised a ballyhoo, claiming a 'Soviet laser experiment revealed'! Of course these aircraft had nothing to do with lasers; in reality the Soviet laser testbed was a converted IL-76M 'Falsie', CCCP-86879 (c/n 0013430893, f/n 2304).

The aircraft was modified extensively enough to warrant a separate designation, A-60 – indicating the Beriyev OKB had a hand in the matter; another reported designation was 'IL-76 version 1A'. The appearance of the A-60 could easily be described as hair-raising. The weather radar was replaced by a big bulbous fairing reminiscent of the C-135N Apollo Range Instrumentation Aircraft, if rather smaller. This probably housed a target acquisition/tracking antenna dish turning every which way.

The extensive navigator's glazing was almost entirely faired over, leaving only two small windows each side. Two gas turbine power units identical to those of the IL-76PP flanked the forward fuselage, resulting in the same structural changes (deletion of the forward emergency exits, relocation of the APU and so on.)

The laser gun was installed in a retractable dorsal turret aft of the wings. The cutout was closed by inward-retracting doors made up of several sections. To compensate for this the cargo doors were removed and faired over to add structural stiffness to the rear fuselage; the cargo ramp remained but was non-functional.

Trials began in 1981 and proceeded for some time, yielding valuable information. However, the aircraft had to be written off at Chkalovskaya AB after a ground fire. Tests were resumed on the second example of the A-60 also known as 1A2. This aircraft made its first flight on 29th August 1991 captained by test pilot V. P. Dem'yanov. The new aircraft featured a new version of the laser equipment taking into account the results obtained in test flights of the first machine. The work on perfecting these systems, supervised by Deputy General Designer N. A. Stepanov, was said to be still in progress in 2002.

As for the American programme, it was halted for some time, but in the mid-90s it was revived when the Boeing Company started work on an airborne laser platform derivative of the Boeing 747-400F freighter.

Iraqi conversions

IL-76MD refuelling tanker

The Iraqi Air Force developed several versions of the IL-76 on its own account. In 1988 one 'true' IL-76MD was converted into a single-point refuelling tanker for the IrAF's Dassault Mirage F1EQ-200 fighter-bombers, as well as Mikoyan MiG-27 *Flogger-D* attack aircraft and Sukhoi Su-22M4 *Fitter-K* fighter-bombers retrofitted locally with Mirage F1 fixed refuelling probes. Unlike the IL-78, the refuelling pod – probably a Douglas D-704 'buddy' refuelling pack, a number of which had been supplied for the Mirages – was carried on the centreline on a pylon fitted to the cargo ramp (!). This obviously required extreme caution on take-off and landing so as to avoid making contact with the runway. The aircraft wore a grey/white air force colour scheme but no IrAF insignia or civil registration.

Baghdad-1 AWACS

Also in 1988 an unidentified IL-76MD 'Falsie' was converted into an AWACS aircraft named Baghdad-1. A Thomson-CSF Tigre surveillance radar manufactured locally under French licence was installed under the aft fuselage in a huge GRP fairing supplanting the cargo doors; the cargo ramp remained but was inactive, of course. The aircraft wore standard Iraqi Airways livery but the airline logos and registration were painted out.

Iraqi specialists claimed that the radar, which was manned by four operators, had a scan 'substantially in excess of 180°' and could detect, identify and track targets at up to 350 km (217 miles) range. Since in its basic form the Tigre is mounted on a semi-trailer, changes had to be made to the radar set for airborne installation in order to reduce ground clutter. Tactical information was transmitted in real time by data link or voice link; the aircraft also featured indigenous radio and radar ESM equipment.

The Baghdad-1 was actually used operationally in late 1988 during the early stages of the Gulf War (that is, the Iraqi invasion of Kuwait), but there have been no reports of its efficiency. What is certain is that the unconventionally located radar antenna, besides having a limited scan, was extremely vulnerable on take-off and landing.

Adnan-1 (Baghdad-2) and Adnan-2 AWACS

Obviously unimpressed by the performance of the Baghdad-1's radar installation, the Iraqis fitted another IL-76MD 'Falsie' with a conventional rotodome mounted on twin pylons immediately aft of the wings. Despite the apparent similarity to the A-50 and 'aircraft 976', this aircraft also had the Tigre radar; the rotodome was similar in diameter to the Soviet types (some 9 m/29 ft 6 in) but the metal centre section was much wider and the dielectric portions smaller. Two long trapezoidal splayed strakes were fitted to the aft fuselage sides to compensate for the destabilising effect of the rotodome. It was claimed that the integration and debugging effort had been undertaken entirely in Iraq but Western aviation experts took this with a grain of salt.

Originally known as Baghdad-2, the second Iraqi AWACS was soon renamed Adnan-1 in memory of Defence Minister Gen. Adnan Khajrallah Talfah killed in a helicopter crash in May 1988. (Rumour has it that Gen. Khajrallah Talfah opposed President Saddam Hussein over some issue and Saddam had the dissenter eliminated.) The aircraft had a grey/white colour scheme but no insignia other than an Iraqi flag on the fin and the inscription Adnan-1 in Arabic on the nose. It was soon joined by a third AWACS, an identically converted IL-76MD 'Falsie' named Adnan-2 which wore full Iraqi Air Force insignia and two-tone grey wraparound camouflage but, once again, no serial.

Development projects

IL-96 (first use of designation)

On 1st June 1972 the Ilyushin OKB began development of a convertible passenger/cargo version of the IL-76 designated IL-96. However, this remained a 'paper airplane' and the designation was subsequently reused for the widebody airliner we know today.

IL-76TD-90 and IL-76MD-90

While the IL-76MF was in the making, the International Civil Aviation Organisation (ICAO) toughened its regulations concerning noise and emission levels. The 'sixties-vintage D-30KP turbofan no longer met the stringent requirements; at best this meant big fines and at worst the IL-76 could be barred from international routes. This, of course, was totally unacceptable, since the IL-76 is used a lot for cargo charters in Western Europe and elsewhere (for example, you're sure to see plenty of *Candids* any time at Sharjah). A ban on IL-76 operations in Europe would bite a big hole in the CIS airlines' trade.

As the next-best thing the Ilyushin OKB proposed upgrading existing IL-76TDs by re-engining them with PS-90A-76 turbofans and updating the avionics. The resulting combination was designated IL-76TD-90; service entry was optimistically planned for mid-1993.

However, the programme was plagued by delays. In February 1994 the would-be prototype, Aeroflot Russian International Airlines' RA-76751 (c/n 0083487610, f/n 6603), finally arrived at Khodynka for conversion at Ilyushin's experimental shop (MMZ No.240). Unfortunately, when it was halfway through the conversion the price of the engines skyrocketed; neither ARIA nor the OKB could afford a complete shipset at that moment, and the work came to a standstill. Eventually ARIA announced its decision to purchase new IL-96T freighters and the IL-76TD-90 was abandoned.

Recently, however, Russian airlines have shown an interest in reviving the project. This is because new noise regulations (which the old engine no longer meets) were introduced in 2002, barring the D-30KP-powered versions from flying to Western Europe. According to some reports, by mid-2003 Russian air carriers had confirmed their wish to have the D-30 engines replaced by the PS-90A-76s on 20 IL-76s. One of these carriers is the well-known company Volga-Dnepr; its re-engined IL-76s are to be known as IL-76TD-90VD.

A project designated IL-76MD-90 is also known to exist. This is obviously the military equivalent of the IL-76TD-90 – a *Candid-B* re-engined with PS-90A-76s. It was reported in April 2003 that re-engining of the first two IL-76s for the Russian Air Force had started at Voronezh Aircraft Plant.

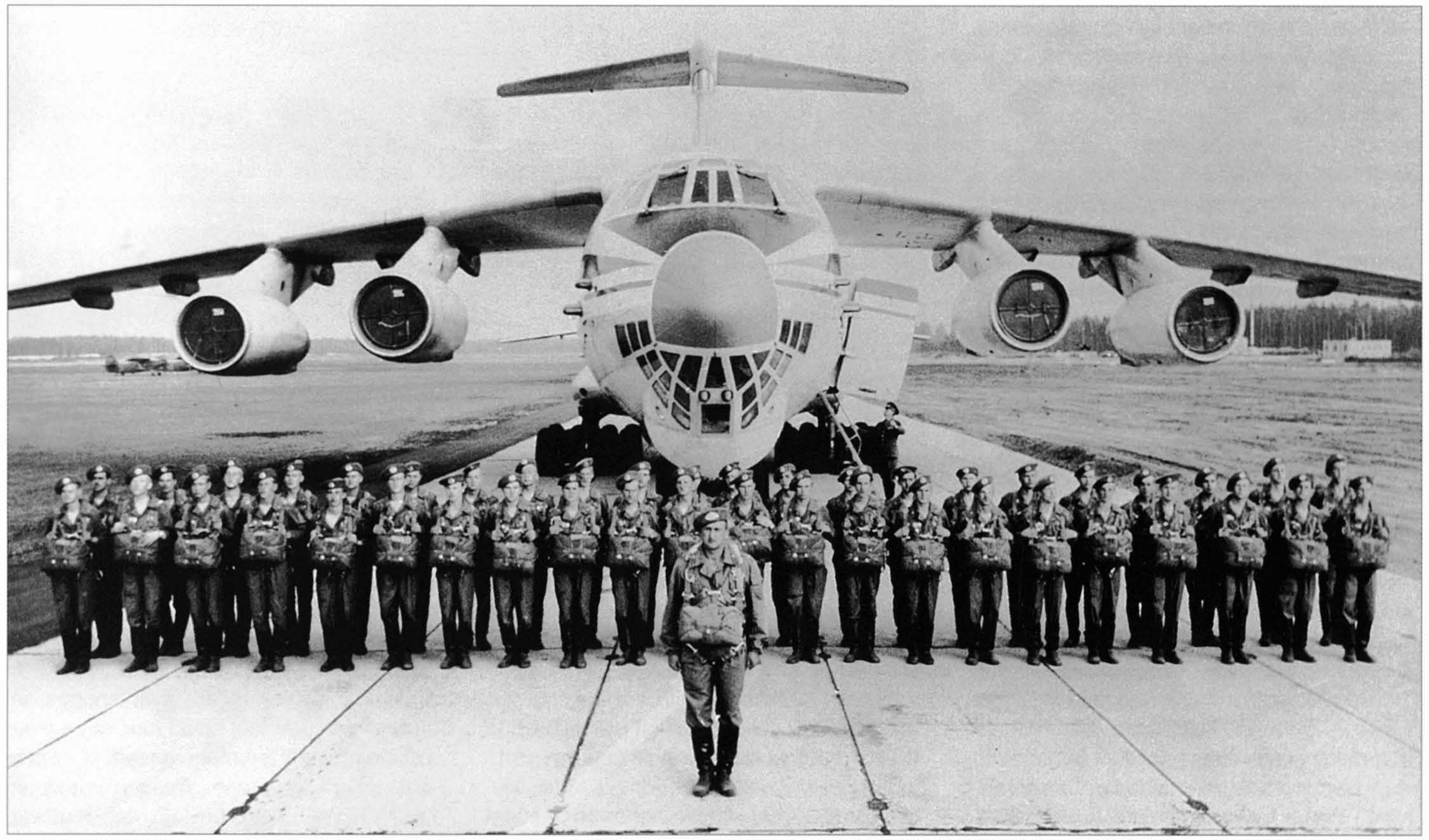
'Westernisation' projects (IL-76MF-100/TF-100 etc)

The Soviet Union had had scant success in exporting its commercial and transport aircraft; exports were largely limited to socialist bloc and third-world nations. Politics and the Cold War (which meant maintenance and spares procurement could turn into a major problem) were the main reason, of course, but not the only one. Western customers were unwilling to buy Soviet hardware because of, as the American aviation writer Clive Irving put it, *'Russian aviation's serious and persistent handicap – its brutish and appallingly 'dirty' jet engines.'*

While Soviet aircraft as such were often regarded as quite capable, sales prospects were crippled by low engine life and mean time between overhauls, poor operating economics and high noise/emission levels. Thus, re-engining was the obvious solution. In the early 1990s the Soviet design bureaux began offering export versions of new commercial aircraft with Western engines and avionics – for example, the Tu-204-120/-130 with Rolls-Royce RB.211-535E4 or Pratt & Whitney PW2040 turbofans respectively, the An-38-100 with Allied Signal TPE331-14GR-801E turboprops and Hartzell M11276NK-3X propellers, the IL-96M/T with PW2337s and so on.

Re-engining existing Soviet aircraft was also considered (for example, Tu-154M with P&W JT8D-217s etc). One such project came up in 1991 when Ilyushin offered a version of the IL-76MD powered by 14,152-kgp (31,200-lbst) CFM International CFM56-5C2s to the French *Armée de l'Air*. The deal failed to materialise – apparently for political reasons.

(In April 2000, however, the project was revived when Ilyushin and the Uzbek Government signed a memorandum of understanding concerning the delivery of five CFM56-powered IL-76MFs. Ilyushin's General Designer Igor' Katyrev says Western certification will not be sought because the



Yefim Gordon archive

Say 'cheese'! The Blue Berets, as the Soviet paratroopers are known, remain as grim-faced as ever, but the IL-76MD they are to flying displays its trademark big grin. Note the ECM blisters on the navigator's glazing frame.

basic *Candid* was certificated to Soviet NLGS-3 airworthiness regulations and not today's AP-25 equivalent of the USA's FAR25 and Europe's JAR25. However, the CFM56-5C4 is a reliable engine and will allow the IL-76MF-100 (or commercial IL-76TF-100) to operate into noise-sensitive airports.)

Later, International Aero Engines picked up the ball, offering to refit the *Candid* with V2500 turbofans. The project was announced at the Aviadvigatel'-93 (Aero Engine-93) exhibition in Moscow in June 1993. This, too, remained a 'paper airplane'; lack of funding was the reason this time.

IL-76 firebomber (yes, indeed)

An interesting project was presented by the Aviaspetstrans consortium at the Moscow Aerospace '90 trade fair. It envisaged the use of the IL-76 as a firebomber – literally. The aircraft was to drop capsules filled with a fire retardant which was spread by means of an explosive charge (!). A single capsule covered an area of 5 m^2 (53.8 sq ft) and a full 'bomb load' was enough for 1 hectare (107,600 sq ft). The 'bombs' were test-dropped successfully from an An-32 but the project was terminated at the insistence of the Ilyushin OKB. Ilyushin claimed the explosive capsules could injure people in the fire zone. Still, perhaps they were just worried about competition...

IL-76PSD

The sad fate of the IL-76MDPS did not put off the Ilyushin OKB. Future development plans for the *Candid* family include the IL-76PSD project. The D stands for ***dahl'niy*** (long-range) and longer range is probably obtained by fitting more fuel-efficient Solov'yov PS-90A-76 turbofans. Thus the designation IL-76PSD almost certainly applies to a version of the IL-76MF adapted for SAR duties.

The stretched fuselage enables the IL-76MF to carry two Gagara lifeboats instead of one. By dropping these and inflatable rescue rafts the aircraft can provide for the rescue of up to 1,000 persons at a time. The project also envisages an A-50 style flight refuelling probe; with aerial refuelling from an IL-78 tanker, the aircraft can stay airborne for up to 16 hours and have a 6,000-km (3,243-nm) operating radius. The avionics suite may include a Kvitok (Coupon) long-range radio navigation (LORAN) system, a Gori-M (Gori is the name of a city in Georgia) integrated navigation system, sea state measurement equipment and an optoelectronic search system

IL-76Kh cryogenic powerplant technology testbed

On 10th October 1974 the Minister of Aircraft Industry and the Soviet Air Force C-in-C endorsed the ***Kholod**-2* (Cold-2) research and development plan for the design bureau led by Vladimir Mikhaïlovich Myasishchev (OKB-23). The objective was to develop a hypersonic aerospaceplane with a cryogenic powerplant, hence the 'cold' name.

Known at OKB-23 as 'Project 19', the programme was split into several parts, the first of which, Project 19-1, was concerned with a propulsion technology testbed. It involved fitting an IL-76 transport with an experimental turbojet (a product of the OKB led by Arkhip Mikhaïlovich Lyul'ka) running on liquid hydrogen (LH_2); the heat-insulated LH_2 tanks would be housed in the freight hold. The aircraft was designated IL-76Kh, the suffix letter referring to the Kholod-2 programme.

Unfortunately, the Powers That Be intervened; when development was well advanced the Myasishchev OKB was ordered to transfer its know-how to the Tupolev OKB. There the programme bore fruit in the form of the Tu-155 technology demonstrator, a highly modified Tu-154 *sans suffixe* (*Careless*) medium-haul airliner. Fitted with a Kuznetsov NK-89 cryogenic engine in the starboard nacelle, the Tu-155 (CCCP-85035, c/n 73A035) made its first flight on 15th April 1988.

Fly-by-wire IL-76

In March 1997 the Russian magazine *Ves'nik Vozdooshnovo Flota/Air Fleet Herald* wrote that Ilyushin were planning an upgraded version of the IL-76 with fly-by-wire controls, a 'glass cockpit' and a crew of two (*sic*).

IL-76 rocket launch aircraft

In 1995 TsAGI materials featured a project envisaging the use of the IL-76 for launching small satellites. The aircraft would disgorge the launch rocket in flight 'head first' by means of a drogue parachute, just like in an ordinary paradrop, whereupon the rocket would fire up and go 'up, up and away'. A similar project designated An-124AK was developed for launching larger rockets. The projects were probably abandoned in favour of the Tu-160SK carrying the Burlak launch vehicle (which still has not progressed beyond the full-scale mock-up stage).

IL-76MF drone launcher version

At the MAKS-95 airshow NPO Mashinostroyeniye unveiled the project of a drone carrier aircraft based on the stretched IL-76MF. The aircraft was to carry a large unmanned aerial vehicle called GLL (*ghiperzvookovaya letayuschchaya laboratoriya* – 'hypersonic flying laboratory', that is, research vehicle) piggyback in similar fashion to NASA's Boeing 747SCA shuttle carrier aircraft.

The aircraft could also carry what could be called an 'aerial sandwich' – a suborbital launch system consisting of the same hypersonic UAV which, in turn, carried a single-stage booster rocket that would put satellites into orbit. Curiously, a model of this project displayed at MAKS-95 represented a *Candid-B*, not an IL-76MF.

IL-78V and IL-78MK refuelling tankers

The Ilyushin OKB is planning further development of the *Midas*. An IL-76 family development plan presented in late 1993 featured the IL-78V tanker equipped with improved UPAZ-MK-32V pods and the IL-78MK tanker/transport (*konverteeruyemyy* – convertible) with a bigger fuel load developed at the request of the VVS. Development was completed in 1993 but the aircraft still has not entered production for domestic use – solely due to lack of orders, as the Russian Air Force has no money for more tankers. However, a contract was signed in February 2001 for the delivery of six IL-78MKs to India. Deliveries were scheduled to start in 2003. In some sources the 'Indian' version of the IL-78MK is designated IL-78MKI.

IL-150 AWACS

In 2000 the Ilyushin OKB proposed an AWACS aircraft designated IL-150 'based on the IL-76MD-90' (*sic*). This indicates that the aircraft is basically an A-50 powered by PS-90 turbofans.

IL-76 in action

The service career of the IL-76 airlifter started with its introduction into operation with the Air Force. On 13th November 1973 the first production aircraft (CCCP-76500) was temporarily detached to Artsyz airbase near Odessa to participate in a military exercise, giving Air Force crews their first acquaintance with the type. On 28th May 1974 a team of Ilyushin OKB operational support specialists started work in the 18th VTAD (military airlift division) headquartered in Vitebsk; this division became the first to master the type. The manufacturer's flight test programme involving four aircraft (CCCP-86712, -86711, -76500 and -76501) was completed on 9th September 1974. Finally, on 15th December the IL-76 completed its State acceptance trials, and the VTA started taking delivery of the new aircraft. On 21st April 1976 the IL-76 was officially included into the Soviet Air Force inventory.

The IL-76 was operated by VTA units based in Engels, Ivanovo, Klin, Novgorod, Pskov, Smolensk, Ukurey and Ul'yanovsk in Russia; Vitebsk in Belorussia; Artsyz (near Odessa), Bel'bek, Dzhankoy, Krivoy Rog, Melitopol'-1, Melitopol'-2, Uzin and Zaporozhye in the Ukraine; Baku and Gyandzha in Azerbaijan; Tartu in Estonia; Kedainiai, Panevezhis and Siauliai in Lithuania. After the break-up of the Soviet Union the units in Gyandzha, Tartu, Kedainiai, Siauliai and Panevezhis were transferred to Russia in 1992-93.

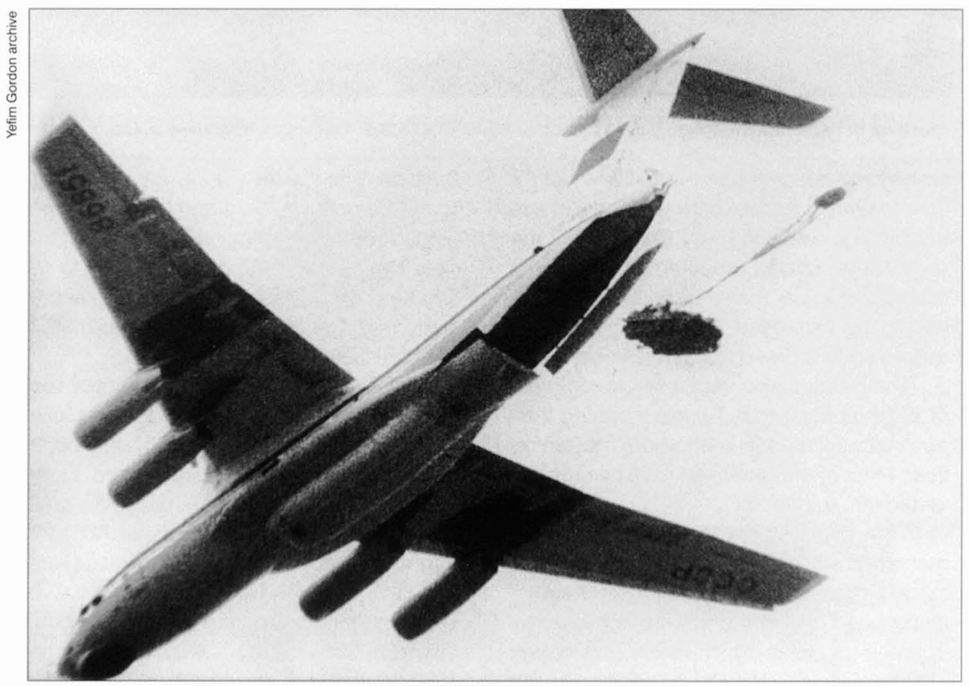
Until the mid-80s, Soviet Air Force *Candids* ostensibly wore standard Aeroflot colours and civil registrations – and nearly all of them still do. In the late 1980s, however, aircraft with overt military markings began appearing.

In operational service the IL-76 earned a good reputation for high reliability and ease of maintenance even in the harshest environments. The type was well liked by the Air Force, since its capacious freight hold, excellent field performance, high speed and payload, and not least reliability gave the VVS a much-needed boost in strategic airlift capability. The IL-76 could airlift a T-72 main battle tank and drop single loads weighing up to 47 tons (103,615 lb) from an altitude of up to 4,000 m (13,120 ft) and a load of paratroopers from up to 8,000 m (26,250 ft).

New paradropping techniques were gradually developed. On 19th June 1978 CCCP-76500 performed the first drop of four cargo pallets using the so-called 'train technique' (each pallet was extracted by a drogue parachute opened by a rip cord attached to the preceding pallet). This technique allowed the cargo to be dropped on a landing zone 400 m (1,310 ft) long. On 23rd April 1983 a BMD-1 was paradropped in the normal way (using a multi-canopy parachute system and retro-rockets) but with a crew inside.

Quasi-civilian IL-76M/MDs regularly flew resupply and troop rotation missions for the Soviet forces stationed in East Germany. Later, IL-76s and freighter-configured IL-78s were used to carry personnel and materiel during the Russian withdrawal from Germany in 1991-94.

Many VTA units operating the IL-76 were stationed outside Russia – mostly in the Ukraine; after the collapse of the Soviet

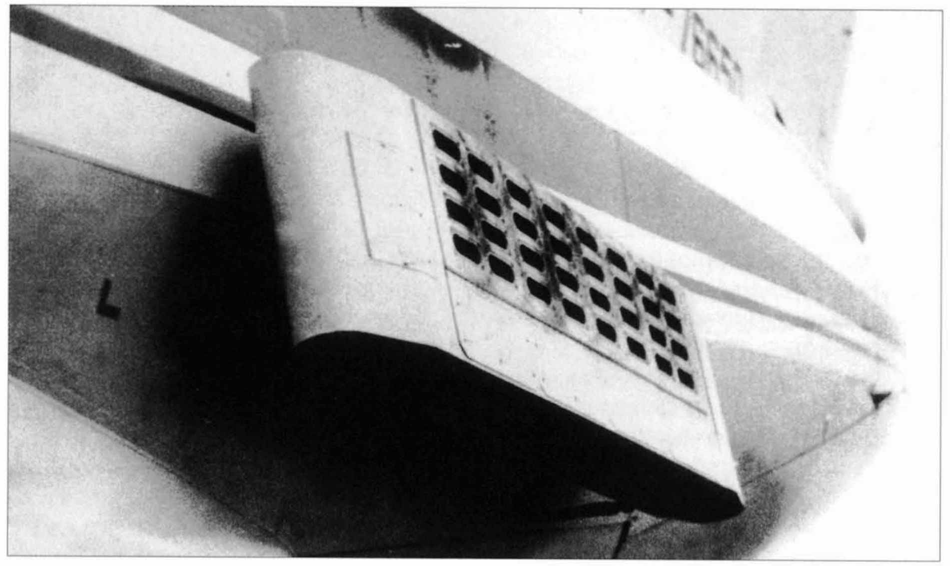


Yefim Gordon archive

IL-76M CCCP-86851 drops a BMD-1 AFV during a joint forces exercise.

ITAR-TASS

Above: Goin' home. Soviet Army soldiers returning from Afghanistan walk past IL-76MDs CCCP-76736 and CCCP-76749 at Tashkent airport; both aircraft are fitted with strap-on APP-50 chaff/flare dispensers.



Ilyushin Aircraft Complex

Close-up of the strap-on APP-50 'suitcases' on IL-76MD CCCP-76650 on which they were tested.

Union they became part of the Ukranian Air Force. With tensions between Russia and the Ukraine being the way they were in the early 1990s, spares procurement became a problem. Hence many Ukrainian *Candids* had to be grounded and cannibalised for spares so as to keep the others flyable.

The Ukraine also kept a whole regiment of IL-78 tankers; thus Russia's strategic air arm lost a substantial proportion of its tanker fleet. Most of the Ukrainian IL-78s were converted into transports.

The civil career of the IL-76 gained momentum in parallel with the type's air force service. Service entry with Aeroflot came soon after the *Candid* attained initial operational capability with the VTA. On 13th May 1975 IL-76 CCCP-76500 began a series of demonstration flights in the Tyumen' Civil Aviation Directorate (CAD), carrying cargo to the Samotlor oil field and the Nadym gas field in Western Siberia. In December of that year the first prototype was loaned to the Tyumen' CAD for evaluation. The aircraft performed excellently in the harsh climate of Western Siberia.

On 22nd December 1976 Aeroflot took delivery of its first IL-76 *sans suffixe*, CCCP-76502 (c/n 063407206, f/n 0602). Later, the IL-76 was also delivered to the Arkhangel'sk CAD/1st Arkhangel'sk UAD, East Siberian CAD/1st Irkutsk UAD/134th Flight, Krasnoyarsk CAD/1st Krasnoyarsk UAD/214th Flight, Domodedovo Civil Aviation Production Association, Uzbek CAD/Tashkent UAD, Volga CAD/1st Kuibyshev UAD/368th Flight and Yakutian CAD/Mirnyy UAD/192nd Flight, the Central Directorate of International Services (TsUMVS)/64th Flight, the Training Establishments Directorate (UUZ – *Oopravleniye oochebnykh zavedeniy*)/ Ul'yanovsk Higher Flying School, as well as to various MAP divisions.

On 5th April 1977 CCCP-76503, by then transferred to TsUMVS/64th Flight, made the first revenue flight outside the Soviet Union, delivering 38 tons (83,770 lb) of fresh vegetables from Sofia. On 26th September 1977 the type began scheduled services with Aeroflot; a further example, CCCP-76504, was delivered in October. Initially the IL-76 *sans suffixe* replaced the An-12 on cargo services in the extreme north, Siberia and the Far East. Soon Aeroflot *Candids* became regular visitors in Western Europe. On 10th July 1979 an Aeroflot IL-76 made the type's first Atlantic crossing on a flight to Cuba.

Soviet Air Force IL-76s were often used for civilian tasks as well, including international flights – especially in the early days when the commercial *Candid-A* was still scarce.

On 8th January 1985 the IL-76T/TD was certificated for compliance with ICAO Annex 16, Chapter 3 regulations limiting jet noise.

On 20th July 1990 IL-76MD CCCP-86871 owned by the Ilyushin OKB paradropped the heaviest load in Soviet history – a 44,600-kg (98,320-lb) dummy spacecraft module used for testing spacecraft parachute recovery systems.

In 1979-91 the IL-76 proved its worth in combat during the notorious Afghan War. Quasi-civilian IL-76s flew resupply and medevac missions for Soviet forces in Afghanistan. These operations were accompanied by occasional losses. On 26th November 1984, IL-76M CCCP-86739 was shot down right over Kabul by Mujahideen guerrillas using a shoulder-launched surface-to-air missile. After this tragic event IL-76 flights into Afghanistan were suspended for almost 18 months while countermeasures and new tactics were developed. First, 96-round APP-50 chaff/flare dispensers were built into the aft portions of the main gear wheel fairings; the flares were fired at preset intervals. A different arrangement was introduced in 1987. Two 96- or 192-round APP-50s were mounted in large streamlined pods on the rear fuselage sides. In addition to protection afforded by the ESM equipment, IL-76 crews used a new piloting technique. The aircraft would stay at about 8,000 m (26,250 ft) until it entered the air defence zone of Kabul Airport, then descend in a tight spiral to minimise the danger of being fired upon. The IL-76 bore the brunt of the transport operations in Afghanistan. By the end of the 12-year war (December 1991) Soviet Air Force *Candids* had made 14,700 flights into Afghanistan, transporting 786,200 servicemen and 315,800 tons (696,208,112 lb) of cargo – 89% and 74% of the total quantity respectively.

Quasi-Aeroflot *Candid-Bs* put in an appearance in other local conflicts. In late 1977 VTA IL-76Ms were used to airlift supplies to Ethiopia's regime waging a losing struggle against separatists in the Eritrea and Ogaden provinces. Soviet Air Force IL-76MDs were also used to extend military support to the pro-Communist Angolan government fighting against UNITA rebels.

The IL-76s were actively used in the First Chechen War (1994-96), delivering troops, equipment and ammunition to Groznyy-Severnyy airport and Mozdok (Ingushetia). The same happened during the Second Chechen War which started in August 1999.

The *Candid* also participated in the Kosovo conflict of 1999. Notably, *Candids* airlifted the main part of the Russian contingent of the multinational peacekeeping forces in Kosovo (KFOR) to Pristina's Slatina airport.

The IL-76 was actively involved in missions associated with polar research. The *Candid's* first polar mission came on 15th September 1982. Two *Candid-Bs* chartered from the VTA paradropped supplies to the ***Sev**ernyy **Pol**yus-25* (North Pole-25, or SP-25) drifting ice station in the Arctic Ocean. On 10th December 1983 IL-76TD CCCP-76473 (then operated by GosNII GA) performed another supply mission for SP-25. Soon polar supply operations became routine. Notable among these were several operations named EksPArk (*Ekspeditsiya 'Parashooty nad Arktikoy'* – 'Parachutes over Arctica' Expedition), performed by the Air Force in the 1980s. In these operations, specially modified lightweight PGS paradroppable pallets were used, as well as specially adapted drop technology.

The *Candids* also became involved in Antarctic research when the need arose to replace the IL-18Ds carrying personnel to and from the Soviet research stations. Two IL-76TDs, CCCP-76478 (c/n 0053459788, f/n 4507) and CCCP-76479 (c/n 0053460790, f/n 4508), were loaned from TsUMVS in 1985. The latter aircraft was fitted with 108 passenger seats, a galley and a toilet. This arrangement was specially developed for the Moscow-Antarctica service.

On 18th February the aircraft flew from Moscow-Sheremet'yevo to Leningrad to pick up a research team going to ice station Molodyozhnaya. Finally, on 22nd February the *Candid* departed from Leningrad-Pulkovo to Larnaca on the first leg of its flight. On 25th February IL-76TD CCCP-76479 finally touched down at Molodyozhnaya, making the type's first landing in Antarctica. In a few days it landed at another Soviet Antarctic station – Novolazarevskaya, delivering supplies. On 1st March CCCP-76479 headed for home, arriving in Moscow three days later; all in all it had delivered 170 persons and some 15 tons (33,070 lb) of cargo. Similar missions to Antarctica were undertaken by IL-76s in November 1988, February 1989 and July 1989.

The services of the IL-76 had to be enlisted in Antarctica once more in July 1991, when a shift of researchers slated to return home got stuck at Ice Station Molodyozhnaya because of a fire on board the vessel that was to take them. As a result of a carefully planned and meticulously executed mission, all 170 members of the research team were airlifted at once.

The next mission to Antarctica took place between 28th October and 13th November 1991. This time IL-76MD CCCP-78839 chartered from the 339th VTAP flew from Moscow to Molodyozhnaya via Leningrad, Larnaca, Nairobi, Antananarivo and Cape Town. From Molodyozhnaya CCCP-78839 made two flights to other Soviet research stations and for the first time in the history of Antarctic supply operations the cargo had to be paradropped.

On 20th April 1998 IL-76MD 'Falsie' RA-76822 captained by N. D. Kuimov paradropped an international expedition comprising 70 researchers from nine countries on the North Pole.

The latest use of the *Candid* for polar research was the Ukraine – North Pole 2000 expedition. On 3rd April An-28 UR-28768 of the O. K. Antonov Central Airclub departed Kiev for Khatanga via Moscow, Syktyvkar, Salekhard and Noril'sk. On 11th April it was followed by an IL-76MD of the Ukrainian Air Force which carried 35 passengers, including TV and newspaper reporters. In Moscow the *Candid* picked up more polar researchers and journalists. The main action took place on 15th April. First, a Mi-8 *Hip* helicopter took off to reconnoitre a landing strip near the Pole for the ski-equipped An-28. Then the IL-76MD came in to paradrop the main team of researchers.

The IL-76 was also much used by United Nations peacekeeping forces in 'hot spots' around the world, notably in the former Yugoslavia. IL-76s – usually in all-white UNPF colours – were frequent guests at Sarajevo's Butmir airport.

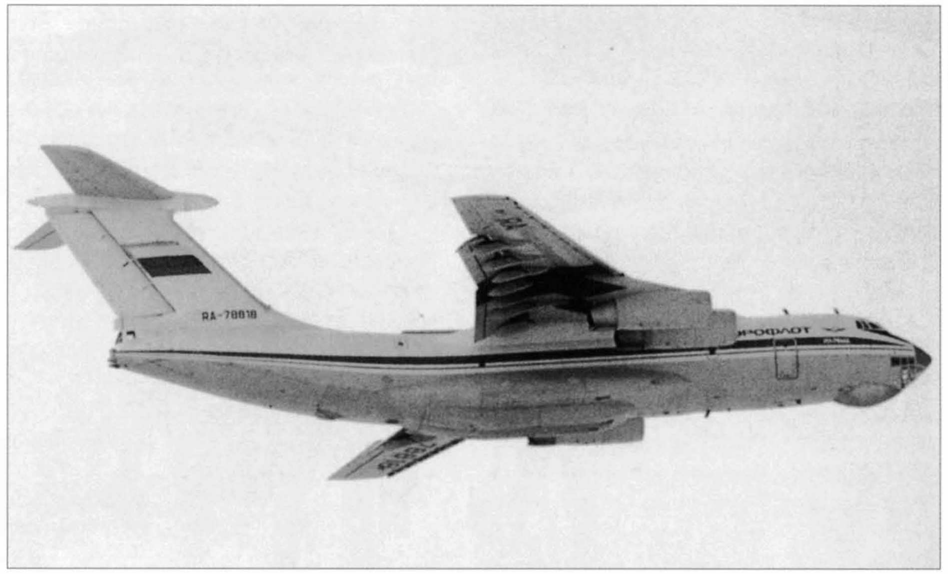
An IL-76TD chartered from Uzbekiston Havo Yullari took part in the humanitarian airlift programme for Sudan put into effect by the United Nations in mid-1992. IL-76s chartered from Ukrainian and Russian carriers proved their worth in the service of several international organisations, such as the International Committee of the Red Cross (ICRC), the United Nations High Commission for Refugees (UNHCR), the United Nations World Food Programme (WFP).

Political developments and economic turmoil in the former Soviet Union have slowed the IL-76's production rate considerably. Nevertheless, the *Candid* looks set to stay in production for quite some time yet, and new advanced versions may still appear. On 7th May 1998 Uzbek President Islam A. Karimov paid a visit to the Ilyushin OKB during his trip to Russia. This resulted in the signing of an agreement granting Uzbekistan exclusive production rights for the IL-76 family.

Later, the Russian side appears to have regretted this step, because of certain frictions with Uzbekistan and the wish of the Russian Air Force to have a home source for eventual deliveries of the updated IL-76MF. In September 2003 Russian authorities reportedly came to a firm decision to trans-

Yefim Gordon archive

A major airborne operation is brewing. IL-76s *sans suffixe* CCCP-86806, -86810 and -86635 prepare to swallow two BMD-1s each.



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Above: Russian Air Force IL-76MDs, including RA-78818, airlifted the Russian KFOR contingent to Pristina-Slatina airport, Kosovo, in the summer of 1999.

fer the manufacture of the IL-76MF to Russian aircraft plants. In accordance with the State Armament Development Programme for the period up to 2010, the IL-76MF is to be adopted for the Air Force Service at the end of 2004 and its series manufacture is to begin in 2005.

Currently the Russian Air Force's acquisition plans include both the IL-76MF and the An-70; the Russian order for the latter was considered finally confirmed and the aircraft was due to enter production at the Aviacor factory in Samara. However, the prospects of the An-70 were called into question when the Russian Air Force Commander-in-Chief Vladimir Mikhaïlov openly declared his opposition to adoption of the An-70 by Russia. The anti-An-70 lobby in Russia was reinforced by the crash of the second prototype (UR-NTK), in Omsk on 27th January 2001 due to double engine failure on take-off. The Russian government, unwilling to give up the politically important deal with the Ukraine on the joint production of the An-70, seems determined to press for the implementation of the concluded agreements on this score. This may well end up in both aircraft eventually taking their place in the inventory of the Russian Air Force.

In the meantime, the IL-76 is still going strong on the international air cargo transport market where it has carved itself a stable niche. However, *Candids* belonging to civil operators are in urgent need of an upgrade (first and foremost re-engining with 'cleaner' and quieter turbofans).

In any case, the IL-76's future with military and commercial operators looks assured.

IL-76 in detail

The following structural description applies to the basic IL-76 *sans suffixe*. Details of other versions are indicated as appropriate.

Type: Four-engined heavy military and commercial transport. The airframe is of all-metal construction.

Fuselage: Semi-monocoque stressed-skin structure, made up of four sections: the forward fuselage (frames 1-18), the centre fuselage (frames 18-67), the aft fuselage (frames 67-90) and the rear fuselage or tail section (frames 90-95). Maximum fuselage diameter is 4.8 m (15 ft 9 in) and maximum cross-section area less main gear fairings is 18.09 m^2 (194½ sq ft). There are two (on the *Candid-A*) or three independent pressurised compartments: the crew section, the freight hold and, on the *Candid-B*, the tail gunner's compartment. The freight hold can be decompressed in flight for paradropping cargo or troops.

The *forward fuselage* houses the crew section with the flightdeck above and the navigator's compartment below it. Both are accessed from the freight hold via a passage on the starboard side with a pressure door. The flightdeck accommodates the pilots, flight engineer, radio operator and chief technician; the loadmaster and, on the *Candid-B*, the paradrop equipment operator are

Volga-Dnepr Airlines

IL-76TDs (both true and false) are an important asset for several Russian airlines, including Volga-Dnepr which operated several of the type.

seated in the hold. A toilet is located on the port side.

The forward pressure bulkhead (frame 1) kinked at approximately 80° mounts the weather radar dish covered by a glassfibre radome; a second radome encloses the ground mapping radar antenna mounted under the pressure floor of the navigator's compartment. The space between the forward pressure bulkhead and the flightdeck is occupied by an avionics bay. The nosewheel well is located beneath the navigator's compartment and freight hold. Two forward-hinged (outward-opening) entry doors are located at the rear of forward fuselage; the port door is deleted on the IL-78M, IL-82 and A-50. An escape hatch with a sloping chute (accessible both from the flightdeck and the navigator's station) is provided on the port side.

The *centre fuselage* accommodates the freight hold with a titanium floor. The rear portion is cut away from below, starting at frame 56; the cutout is closed by the cargo ramp which is a continuation of the freight hold floor and extends beyond centre fuselage to frame 69. The ramp incorporates a U-shaped tail bumper and a hydraulically-powered circular telescopic support which extends forwards and downwards to stop the aircraft from falling over on its tail during loading and unloading. Centre fuselage terminates in a flat rear pressure bulkhead which swings upwards and aft almost entirely for loading and unloading. It features an inward-opening pressure door which serves for access to the tail gunner's station on the *Candid-B*.

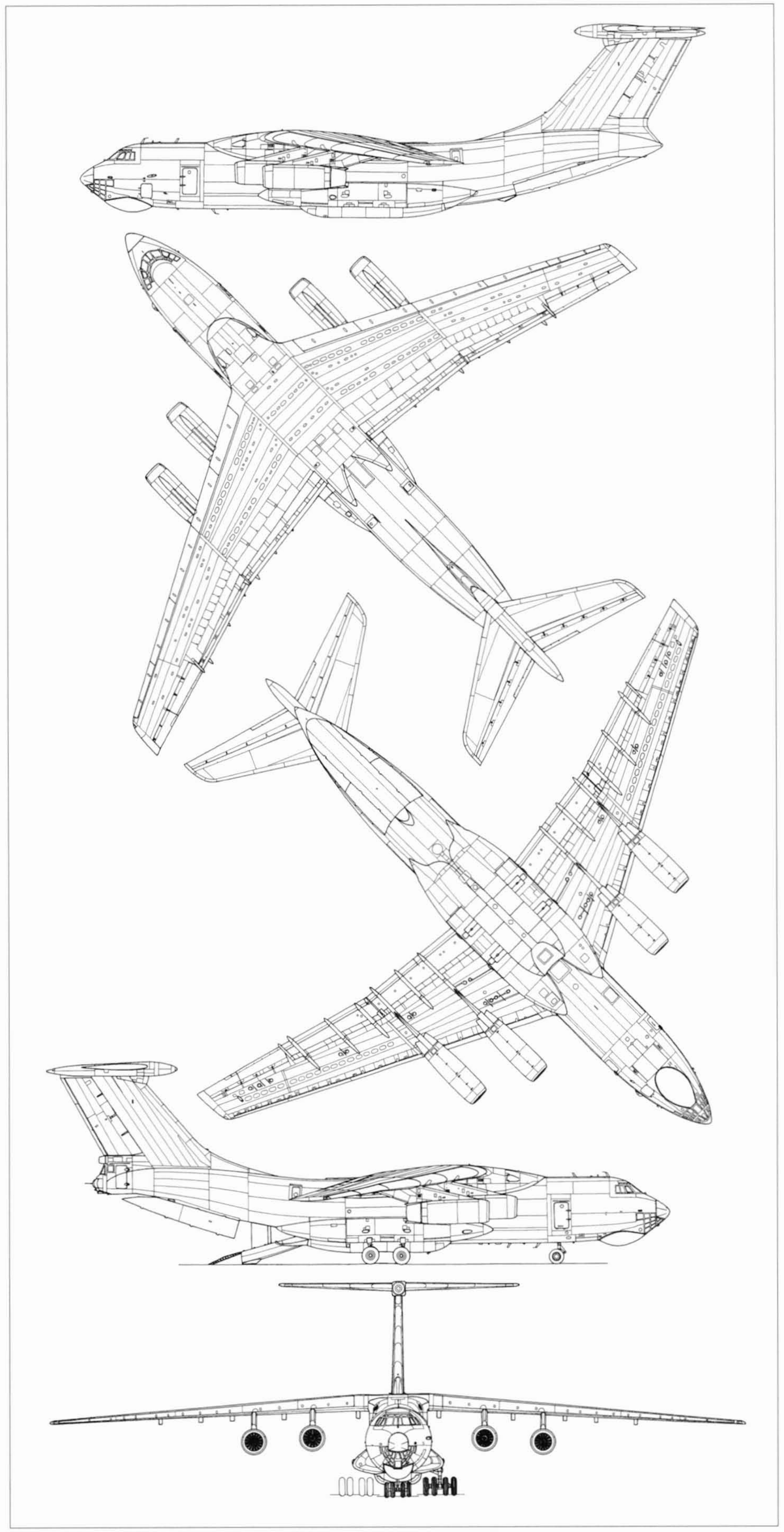
The freight hold measures 20.0 x 3.4 x 3.46 m (65 ft 7½ in x 11 ft 1⅞ in x 11 ft 4¼ in) excluding the cargo ramp, or 24.5 x 3.4 x 3.46 m (80 ft 4½ in x 11 ft 1⅞ in x 11 ft 4¼ in) with the cargo ramp. The rear loading aperture measures 3.4 x 3.45 m (11 ft 1⅞ in x 11 ft 3⅞ in).

The freight hold features attachment points for a removable upper deck for carrying troops. Four emergency exits with circular windows are provided in the hold: two at main deck level ahead of the wings and two at upper deck level aft of the wings.

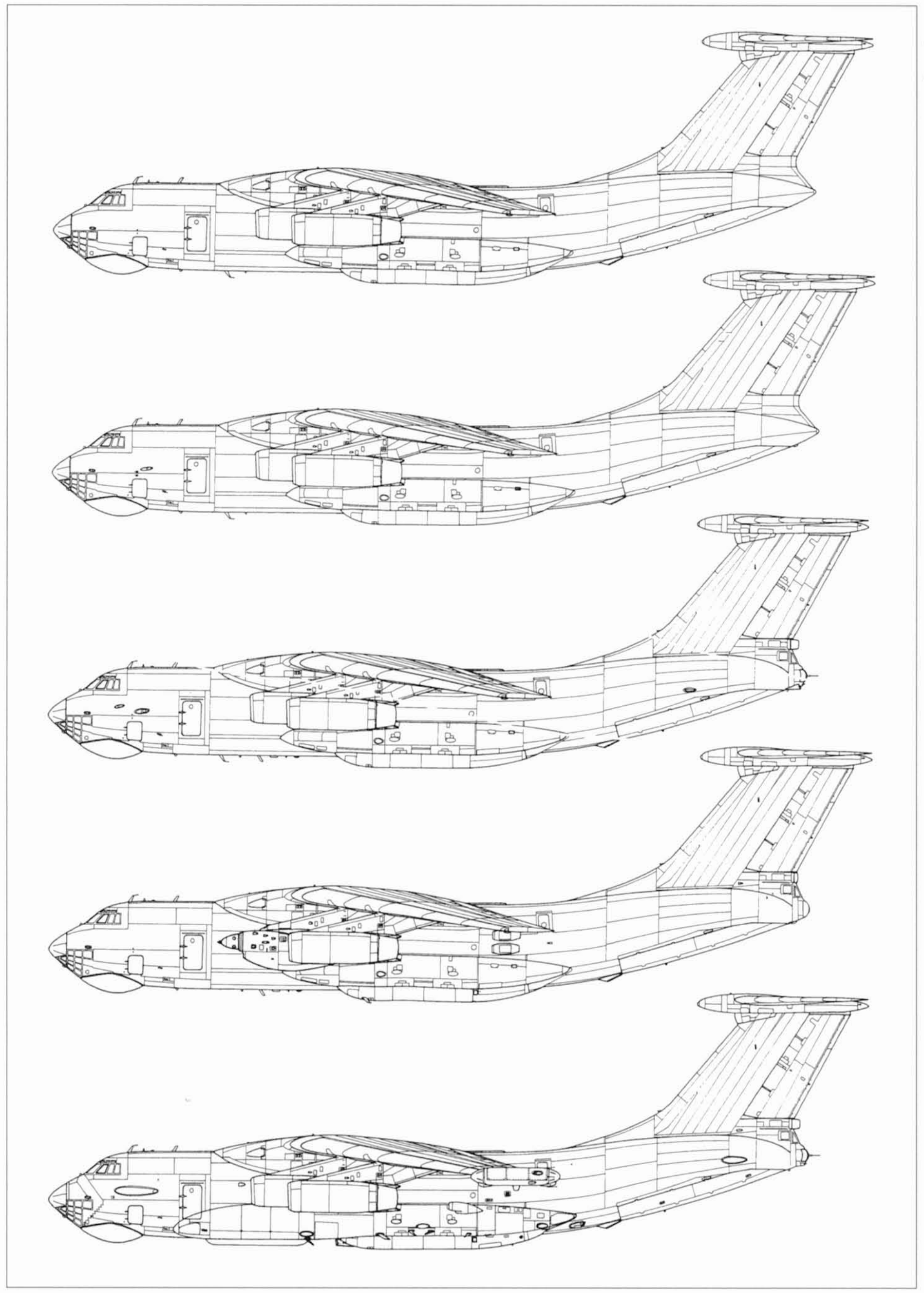
Fuselage mainframes 29, 34 and 41 serve as attachment points for the wing centre section's front, middle and rear spars. The wing/fuselage joint is enclosed by a fairing, the front half of which includes the unpressurised air conditioning system bay. It also houses the slat drive motor and the inflatable rescue dinghy.

Two elongated fairings of quasi-triangular section are located on the centre fuselage sides, enclosing the main gear attachment points and actuators. These fairings accommodate the APU, refuelling panel, DC batter-

Andrey Yurgenson



Four views of the IL-76TD, with an additional starboard side view of the IL-76MD.



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Top to bottom: The commercial IL-76 *sans suffixe*: the IL-76T; the IL-76M; IL-76LL CCCP-06188 with a Klimov TV7-117A development engine; the IL-76PP.

ies, liquid oxygen converter, communications and navigation equipment, stabiliser inspection light; on the *Candid-B* they also house the inert gas generator and reconnaissance camera. Two ventral fairings of circular section enclose the mainwheels.

The unpressurised *aft fuselage* is cut away from below; the cutout is closed by three cargo door segments aft of the cargo ramp (the outer segments hinge outwards and the centre segment upwards). The aft fuselage carries the vertical tail.

The *rear fuselage* or *tail section* is just an unpressurised fairing on commercial versions (and IL-76M/MD 'Falsies') or a tail gunner's station on the *Candid-B*. Once again, it is cut away from below to accommodate the rear end of the centre cargo door segment which is hinged to frame 95. On military versions the lower part of tail section is a pressure compartment accessed from the freight hold by walking up the inside of the cargo door and through a pressure door in the front wall. An emergency door is located on the starboard side, opening forwards hydraulically to act as a slipstream deflector for bailing out. The upper part of tail section is unpressurised; on the *Candid-B* this is an avionics bay housing the gun ranging radar with a glassfibre radome. (On the IL-78 tanker, the tail section is a refuelling systems operator's station).

Wings: Cantilever shoulder-mounted monoplane of basically trapezoidal planform, mounted above the fuselage to leave the interior unobstructed; leading-edge sweep constant, trailing-edge sweep increases on outer wings. Sweepback at quarter-chord 25°, anhedral 3° from roots, incidence 3°, camber –3°, aspect ratio 8.5, taper 1.61. The wings utilise TsAGI high-speed airfoils with a high lift/drag ratio throughout the aircraft's speed range; thickness/chord ratio is 13% at root and 10% at tip. Wingspan is 50.5 m (165 ft 8¼ in) and wing area 300.0 m^2 (3,225.8 sq ft).

The wings are all-metal, stressed-skin structures made of D16T duralumin. Structurally they are made up of five pieces: the centre section (which is integral with the fuselage), inner wing sections and outer wing sections, plus tip fairings. The wing sections are joined by attachment fittings on the upper surface and splice plates on the undersurface. The wing/fuselage joint is covered by a fairing (see above).

The centre section and inner wings are three-spar structures, while the outer wings are two-spar structures. The centre section and inner wing ribs (except Nos 10-11 and 17-18) are parallel to the fuselage axis, most of the outer wing ribs are at right angles to the rear spar. The wing skins are chemically milled with integral stringers and incorporate numerous removable access panels for inspection of the integral fuel tanks (located dorsally on the centre section/inner wings and ventrally on the outer wings). The wing leading and trailing edges feature numerous hinged ventral panels for access to control runs, hydraulic and fuel lines, flap and slat drive shafts, electric cables and so on.

Two engine pylons are attached to each inner wing at ribs 10-11 and 17-18. The pylons are respectively 6.35 m (20 ft 10 in) and 10.6 m (34 ft 9⅜ in) from the fuselage centreline. Each outer wing incorporates attachment points for two external stores pylons at ribs 28 and 30.

The wings are equipped with two-section triple-slotted flaps (one section on each inner and outer wing), five-section leading-edge slats (two inboard and three outboard sections), two-section ailerons, four-section airbrakes on the inner wings and four-section spoilers/lift dumpers on the outer wings. The flaps move on external tracks enclosed by fairings. Both inboard slat sections on each side have cutouts to clear the engine pylons when fully deployed. Flap settings are 15° or 30° for take-off and 43°/41° (inboard/outboard) for landing; the slats are deployed 14° (at 15° flap) or 25°. Maximum airbrake and spoiler deflection is 40° and 20° respectively.

Tail unit: Cantilever T-tail of all-metal stressed-skin construction made of D16T duralumin. The vertical tail consists of a fin and one-piece rudder. The fin is a three-spar structure with 20 ribs set at right angles to the rear spar; the spars are attached to aft fuselage mainframes 74, 82 and 86, with five auxiliary fittings in between. Three rudder mounting brackets are located at ribs 10-11, 21-22 and 33-34; an upper rudder support structure extends aft from the rear spar at the top. A small curved root fillet is attached to the centre and aft fuselage (frames 62 to72). Sweepback at quarter-chord 39°, fin area (less rudder) 50 m^2 (537.63 sq ft).

Landing gear: Hydraulically-retractable tricycle type, with free-fall extension in emergency. Five independent units, each with four wheels on a single axle (that is, two pairs each side of the oleo) for soft-field capability. The nose unit has 1,100 x 330 mm (43.3 x 13.0 in) KT-159 wheels and is equipped with a shimmy damper. The four main units are located fore and aft of the aircraft's centre of gravity and have 1,300 x 480 mm (51.2 x 18.9 in) KT-158 wheels. All wheels have multi-disc brakes.

The nose unit retracts forwards, the main units inwards into two circular-section ventral fairings. During retraction the mainwheel axles rotate around the oleos by means of mechanical links so that the wheels stow vertically with the axles parallel to the fuselage axis; the axles of the forward pair rotate forward and the axles of the aft pair rotate aft. The main gear fulcrum (main pivot) attachment fittings on fuselage mainframes 37, 41, 45 and 49 are made of VT16 titanium alloy and the side strut attachment fittings of VT22 titanium alloy.

The nosewheel well is closed by two pairs of doors. Each main unit has a large curved main door attached to the fuselage keel beam, small double doors in the lateral main gear fairings near the oleos and a small door segment hinged to the oleo itself. All doors open only when the gear is in transit; this prevents mud, water and slush from entering the wheel wells.

All landing gear struts have oleo-pneumatic shock absorbers and the nose unit has levered suspension. The steerable nose unit can turn ±50° for taxying; steering is assisted by differential braking, enabling the aircraft to make a U-turn on a runway 40 m (131 ft) wide. Tyre pressure can be adjusted in flight to suit different types of runways.

Powerplant: The IL-76 *sans suffixe*, IL-76M and IL-76T are powered by four Solov'yov (Aviadvigatel') D-30KP turbofans rated at 12,000 kgp (117.7 kN; 26,455 lbst) for take-off, with a cruise rating of 2,750 kgp (27 kN; 6,060 lbst) at 11,000 m (36,090 ft) and Mach 0.8.

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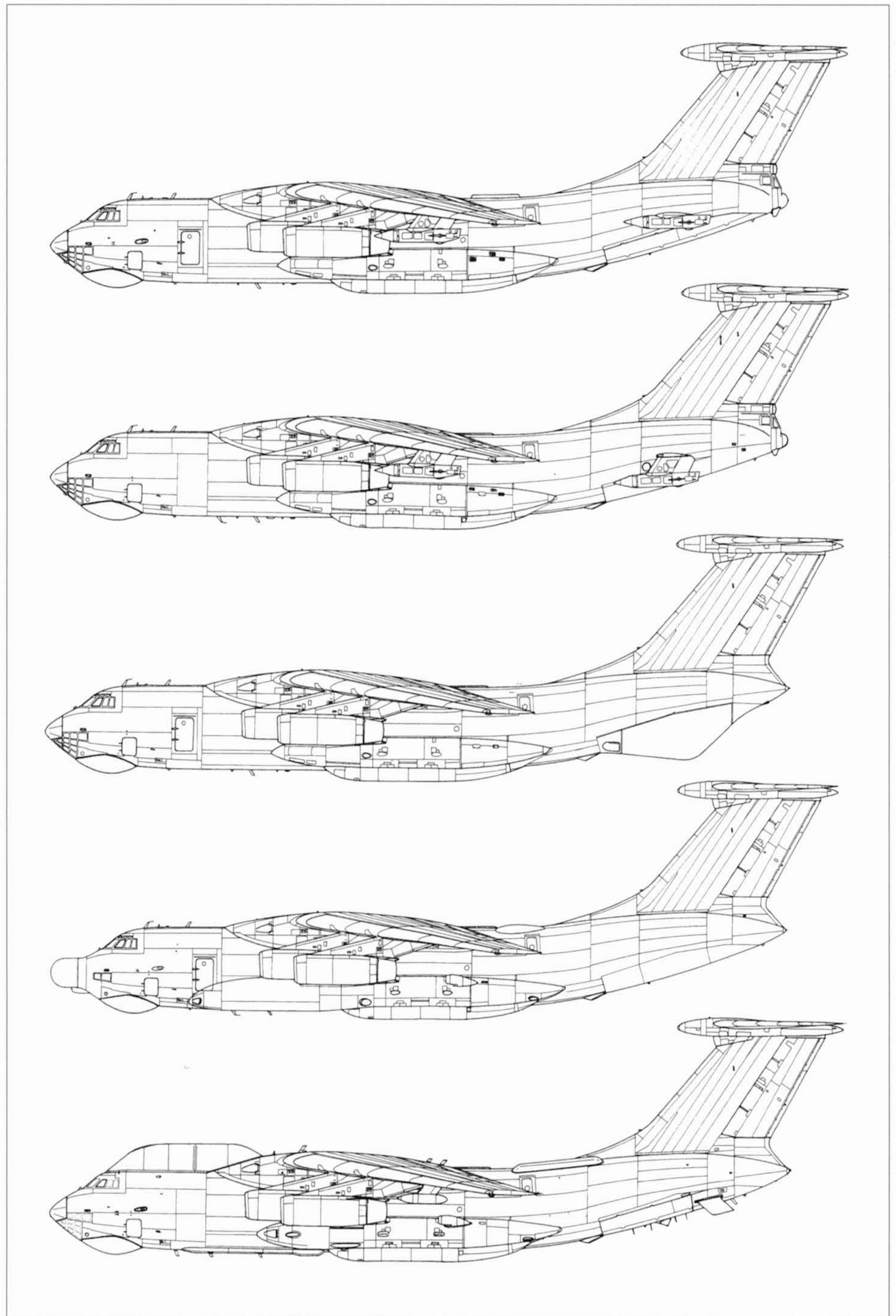
The IL-76MF.



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Top to bottom: the IL-78 tanker/transport (IL-78T); the IL-78M dedicated tanker; the Baghdad-1 AWACS conversion; the A-60 laser weapon testbed; the IL-82 ABCP.

The D-30KP is a two-shaft turbofan with a three-stage low-pressure (LP) compressor, 11-stage high-pressure (HP) compressor, cannular combustion chamber, two-stage HP turbine, four-stage LP turbine, fixed-area jetpipe with 16-chute core/bypass flow mixer, and clamshell thrust reverser. Bypass ratio 2.42; overall engine pressure ratio 20 at sea level (engine speed 96%, that is, HP speed 10,460 rpm), mass flow at take-off 269 kg/sec (593 lb/sec) at LP speed 7,460 rpm. Length overall 5.7 m (18 ft 8½ in), inlet diameter 1.464 m (4 ft 9⅝ in); dry weight 2,650 kg (5,840 lb). Specific fuel consumption (SFC) at take-off rating 0.49 kg/kgp·h (lb/lbst·h), cruise SFC 0.7 kg/kgp·h. Construction is mostly of titanium alloy, with steel used for some HP compressor parts.

The air intake assembly has a fixed spinner and 26 cambered inlet guide vanes (IGVs) de-iced by hot air bled from the 6th or 11th compressor stage; variable IGVs are used on the HP compressor to minimise blade vibration. The division casing is made of magnesium alloy. The combustion chamber has 12 flame tubes, two of which feature igniters; the outer casing and duct shroud are split horizontally for access to the flame tubes. HP turbine blades are cooled by engine bleed air, while LP turbine blades are uncooled.

Two ventral accessory gearboxes (front and rear) are provided, one of which has a constant-speed drive for the AC generator and starter. The lubrication system incorporates a fuel/oil heat exchanger and uses VNII NP-50-1-4F synthetic oil or equivalent. The engine is started by an STV-4 air turbine starter fed by the APU, ground supply or cross-bleed from other engines.

The engines are mounted in individual nacelles on large forward-swept pylons under the inner wings. Each nacelle consists of a one-piece annular forward fairing, four hinged cowling panels and a multi-segment rear fairing. All of these are attached directly to the engine casing, and the nacelle can be disassembled completely or partly, leaving the engine on the wing.

The IL-76MD, IL-76TD and their derivatives have D-30KP Srs 2 turbofans uprated to 12,500 kgp (27,557 lbst) which maintain full power up to ISA +23°C (some sources indicate +27°C) instead of ISA +15°C.

Control system: Powered controls with irreversible hydraulic actuators on ailerons, rudder and elevators. Unusually, the actuators are self-contained units, each with its own hydraulic reservoir and electrically-driven pump. There is a manual emergency backup mode with conventional mechanical controls (push-pull rods, cranks and levers). The mechanical control runs are duplicated (except rudder control) and routed along opposite sides of the fuselage for greater survivability. An autopilot is fitted.

Roll control is provided by two-section ailerons and four-section spoilers/lift dumpers on the outer wings. The ailerons have trim tabs on the outer sections and servo tabs on the inner sections. Aileron deflection is 28±1° up and 16±1° down, spoiler deflection for roll control 20°.

Pitch control is provided by one-piece elevators. Each elevator incorporates a geared tab (ribs 1-23). Each elevator is hinged on one root support and five brackets. Elevator deflection is 21±1° up and 15±1° down

Directional control is provided by a one-piece rudder featuring a servo tab and a trim tab. It is hinged on three brackets, plus upper and lower support posts located aft of the fin torsion box. Rudder deflection is ±28° 30'.

Fuel system: The wing torsion box (centre section, inner and outer wings) is divided into 12 integral fuel tanks and two vent surge tanks. The fuel tanks are split into four groups, one for each engine; each group has a service tank from which fuel is fed to the respective engine.

The IL-76 has single-point pressure refuelling; the refuelling panel is located on the port main gear fairing between the main gear units. Operation of fuel transfer and delivery pumps is completely automatic.

An inert gas pressurisation system is provided on military versions to pressurise the fuel tanks and reduce the hazard of explosion if hit by enemy fire. This includes an inert gas generator in the front portion of the starboard main gear fairing breathing through a small air intake.

Hydraulics: Two separate hydraulic systems which power the landing gear, flaps, slats, airbrakes, spoilers/lift dumpers, cargo ramp/doors, tail support and, if required, entry doors (for paradropping) and escape chute door.

Electrics: AC power supplied by engine-driven generators and APU generator; the electric system includes DC converters. Backup DC power is provided by battery in the starboard main gear fairing. Ground power receptacle under the front end of the starboard main gear fairing.

Oxygen system: Liquid oxygen (LOX) bottles and a LOX converter are installed in one of the main gear fairings to provide breathing oxygen for the crew and troops in the freight hold.

Air conditioning and pressurisation system: The crew section, freight hold and, on the *Candid-B*, the tail gunner's compartment are pressurised by engine bleed air to a pressure differential of 0.5 ± 0.02 kg/cm^2 (7.14 ± 0.28 psi). The pressurisation air is cooled by two heat exchangers located in the forward portion of the wing/fuselage fairing, with ram air intakes and lateral air outlets.

Fire suppression system: Three groups of fire extinguisher bottles charged with 114V_2 grade chlorofluorocarbon extinguishing agent for each engine. The first group is triggered automatically by flame sensors in the engine nacelles; the second and third groups are manually operated. A separate fire extinguisher for the APU bay.

De-icing system: The wing leading edge and engine air intakes are de-iced by engine bleed air. Electric de-icing on the fin and stabiliser leading edges, pitot heads, static ports and flightdeck/navigator's station glazing.

Accommodation/cargo handling equipment: Tip-up seats along the freight hold walls. In paradrop configuration a double row of quickly removable seats, back to back, can be installed down the centre of the freight hold on the *Candid-B*. Static line attachments can be configured in different ways, depending on what is to be dropped (cargo or troops) and whether troops are to be dropped through the cargo door, entry doors, or both. A siren and illuminated signs are provided for initiating the drop sequence.

The freight hold floor incorporates four fold-away roller conveyors for container/pallet handling, recessed cargo tiedown points and fittings for special equipment (for example, stretcher supports allowing the aircraft to be configured for the CASEVAC role). Loads are secured by chains and turnbuckles. Removable roller conveyors can be fitted to the cargo ramp.

The cargo ramp houses four manually-retractable vehicle loading ramps. These are normally fitted four-abreast with the ramp fully lowered and the tail bumper resting on the ground. If a long vehicle has to be loaded, the cargo ramp is lowered only partially and set at approximately 6° and the vehicle loading ramps are attached consecutively, with auxiliary supports in between. Two LPG-3000A winches developing 3,000 kgf (6,610 lbf) are installed under the freight hold floor for loading trailers and the like.

Four electric cargo hoists capable of lifting 2,500 kg (5,510 lb) each move on rails which run the full length of the freight hold roof, continuing over the rear pressure bulkhead and beyond it (the cargo door centre segment fits between them). This enables the hoists to move 5.65 m (18 ft 6½ in) beyond the cargo ramp for straight-in loading of containers and the like weighing up to 10,000 kg (22,045 lb) from a truck bed or a trailer. The cargo ramp may also be used to lift loads weighing up to 30 tons (66,140 lb); in these cases the retractable support is used.

Armament (*Candid-B*): One UKU-9K-502-1 tail turret with two Gryazev/Shipoonov GSh-23 double-barrel 23-mm (.90 calibre) cannons. Ranging and aiming is by means of a PRS-4 Krypton (*izdeliye* 4DK, NATO *Box Tail*; PRS = *pritsel **rah**diolokatsi**on**nyy, strel**kov**yy* – gunner's radar sight) gun ranging radar installed at the base of the rudder above the gunner's station. Two small pylons can be fitted under each outer wing for carrying bombs up to 500 kg (1,102 lb) or other stores.

Avionics and equipment:

Navigation and piloting equipment: Full equipment for all-weather day/night operation. The IL-76 features an SAU-1T-2BT automatic flight control system (*sis**tem**a avto**mat**icheskovo oopravl**en**iya*), a DISS-013-S2 or DISS-013-S2M Doppler speed/drift sensor (***dop**lerovskiy izme**rit**el' **sko**rosti i **sno**sa*), an RLS-N weather radar in the extreme nose.

The navigation suite comprises a central digital navigation computer, a TKS-P precision compass system (***toch**naya koorso**va**ya sis**tem**a*), a duplex I-P-76 inertial navigation system and an RSBN-7S Vstrecha (Rendezvous) short-range navigation (SHORAN) system with a flush aerial built into the fin. Military aircraft also have an A-723 long-range navigation (LORAN) system with a dorsal strake aerial offset to starboard aft of the wings.

The aircraft is equipped with an instrument landing system permitting ICAO Cat II automatic approach, with Koors-MP-2 and Koors-MP-70 automatic approach systems (koors = heading), RV-5 and RV-5M radio altimeters (***rah**diovysoto**mer***) linked to a Vektor ground proximity warning system (GPWS), an ARK-15M automatic direction finder (*avto**mat**icheskiy **rah**dio**kom**pas* – ADF), SD-75 and SDK-67 distance measuring equipment (*samo-**lyot**nyy dahl'no**mer*** – DME).

An RLS-P Koopol ground mapping radar with a 360° field of view is installed under the nose. On the *Candid-B* this is aided by an electro-optical sight at the navigator's station for precision paradropping. An RI-65 automatic voice annunciator (*rechevoy informahtor*) warns the crew of critical failures (fire and the like) and dangerous flight modes.

Communications equipment: R-855UM, R-855A1 and R-861 UHF radios with dorsal and ventral blade aerials on forward fuselage. Main and backup *Mi**kron*** (Micron) and *Yad**ro*** (Core) VHF radios with antennas buried in the fin bullet fairing. R-851 emergency radio beacon for sending distress signals. SPU-8 and SPU-15 intercoms (*samo**lyot**noye peregovornoye oos**troy**stvo*).

IFF system: SRO-2M Khrom (Chromium; NATO *Odd Rods*) IFF transponder (*samo**lyot**nyy **rah**diolokatsi**on**nyy ot**vet**chik* – aircraft-mounted radar responder). From approximately 1987 onwards it was replaced by an SRO-1P Parol' (Password, aka *izdeliye* 62-01) IFF transponder on IL-76MDs and other military versions. The IFF aerials are located ahead of the flight-deck glazing and under fuselage section F4, offset to starboard. The aircraft also features SOM-64, SO-70 and SO-72M ATC transponders.

Electronic support measures (ESM) equipment: S-3M Sirena-2 radar homing and warning system (RHAWS) with aerials on the forward/aft fuselage sides and wingtips. Active ECM system (*Candid-B* only) with six teardrop antenna fairings (four on the forward fuselage sides and two on the aft fuselage) to give 360° coverage and two small rounded fairings on the navigator's glazing. Passive ECM provided by KDS-19 *Avto**maht**-2I* (in this case, 'automatic device') chaff dispensers built into the aft

portions of the lateral main gear fairings (*Candid-B* only).

Some IL-76Ms and 'MDs have 96-round APP-50 chaff/flare dispensers firing 50-mm (1.96-in) magnesium flares or chaff cartridges built into the aft portions of the ventral mainwheel fairings as a protection against air-to-air and surface-to-air missiles. Other IL-76MDs have provisions (mounting lugs and electrical connectors) for podded 96- or 192-round APP-50s on aft fuselage sides.

Data recording equipment: Standard Soviet Mars-BM flight data recorder (FDR) and MS-61B cockpit voice recorder (CVR).

Exterior lighting: Port (red) and starboard (green) navigation lights in wingtips. White tail navigation light on tailcone (*Candid-A*) or under tail turret (*Candid-B*), augmented by amber and green formation/ signal lights (used during night paradropping) on the *Candid-B* and IL-76M/MD 'Falsie'. Four retractable landing/taxi lights on forward fuselage sides aft of navigator's station and (on the IL-76 *sans suffixe*, IL-76M and IL-76T) in the middle flap track fairings of the outboard flaps; the IL-76MD and IL-76TD have the wing landing lights moved outboard to the wingtips. Red anti-collision strobe lights on top of wing centre section (offset to starboard) and in the middle of the centre cargo door segment. Faired wing/air intake inspection light on the port side of the forward fuselage (IL-78M, starboard side); buried tail unit inspection light in the rear portion of the port main gear fairing (plus two refuelling pod inspection lights at the same location and one in the starboard fairing on the IL-78/IL-78M). Two floodlights buried in the centre cargo door segment to illuminate the loading area at night. Three 26-mm (1.02-in) ESKR-46 four-round signal flare launchers low on the starboard side immediately aft of the ground mapping radar.

IL-76 family specifications

	IL-76 *sans suffixe*	IL-76M/ IL-76T	IL-76MD/ IL-76TD	IL-76MF/ IL-76TF	IL-78	IL-78M
Length overall	46.59 m (152' 10¼")	46.59 m (152' 10¼")	46.59 m (152' 10¼")	52.34 m (171' 8⅝")	46.59 m (152' 10¼")	46.59 m (152' 10¼")
Wing span	50.5 m (165' 8")	50.5 m (165' 8")	50.5 m (165' 8")	50.5 m (165' 8")	50.5 m (165' 8")	50.5 m (165' 8")
Height on ground	14.76 m (48' 5")	14.76 m (48' 5")	14.76 m (48' 5")	14.45 m (47' 4.9")	14.76 m (48' 5")	14.76 m (48' 5")
Wing area, m^2 (sq ft)	300.0 (3,229)	300.0 (3,229)	300.0 (3,229)	300.0 (3,229)	300.0 (3,229)	300.0 (3,229)
Landing gear track	8.16 m (26' 9¼")	8.16 m (26' 9¼")	8.16 m (26' 9¼")	8.16 m (26' 9¼")	8.16 m (26' 9¼")	8.16 m (26' 9¼")
Freight hold dimensions:						
length, including ramp	24.5 m (80' 4½")	24.5 m (80' 4½")	24.5 m (80' 4½")	30.25 m (99' 2½")	24.5 m (80' 4½")	24.5 m (80' 4½")
length, excluding ramp	20.0 m (65' 7½")	20.0 m (65' 7½")	20.0 m (65' 7½")	25.75 m (84' 5¾")	20.0 m (65' 7½")	20.0 m (65' 7½")
width	3.4 m (11' 1¾")	3.4 m (11' 1¾")	3.4 m (11' 1¾")	3.4 m (11' 1¾")	3.4 m (11' 1¾")	3.4 m (11' 1¾")
height	3.46 m (11' 4¼")	3.46 m (11' 4¼")	3.46 m (11' 4¼")	3.46 m (11' 4¼")	3.46 m (11' 4¼")	3.46 m (11' 4¼")
Freight hold volume, m^3 (cu ft)	321 (11,336)	321 (11,336)	321 (11,336)	400 (14,125)	321 (11,336)	321 (11,336)
Operating empty weight, kg (lb)	n.a.	n.a.	92,000 (202,821)	104,000 (229,276)	98,000 (216,049)	n.a.
MTOW, kg (lb)	157,000 (346,120)	170,000 (374,785)	190,000 (418,875)	210,000 (462,960)	190,000 (418,875)	210,000 (462,960)
Max. landing weight, kg (lb)	135,000 (297,620)	150,000 (330,690)	151,500 (333,995)	165,000	151,500 (333,995)	n.a.
Fuel load, kg (lb)	n.a.	84,840 (187,040)	90,000 (198,410)	90,000 (198,410)	118,000 (260,140) *	138,000 (304,230) *
Max. payload, kg (lb)	40,000 (88,190)	48,000 (105,820)	50,000 (110,230)	60,000 (132,275) †	85,720 (188,980)	105,720 (233,070)
Max. axle load (vehicles), kg (lb)	7,500-11,000 (16,535-24,250)	7,500-11,000 (16,535-24,250)	7,500-11,000 (16,535-24,250)	7,500-11,000 (16,535-24,250)	7,500-11,000 (16,535-24,250)	–
Max. floor loading, kg/m^2 (lb/sq ft)	1,450-3,100 (297-635)	1,450-3,100 (297-635)	1,450-3,100 (297-635)	1,450-3,100 (297-635)	1,450-3,100 (297-635)	–
Max. wing loading, kg/m^2 (lb/sq ft)	n.a.	566.7 (116.05)	633.3 (129.72)	n.a.	n.a.	n.a.
Max. power loading, kg/kgp (lb/lbst)	n.a.	3.54	3.95	n.a.	n.a.	n.a.
Top speed, km/h (mph)	850 (527)	850 (527)	850 (527)	850 (527)	n.a.	n.a.
Cruising speed, km/h (mph)	750-800 (465-496)	750-800 (465-496)	750-800 (465-496)	750 (465)	n.a.	n.a.
Unstick speed, km/h (mph)	n.a.	210 (130)	n.a.	n.a.	n.a.	n.a.
Approach and landing speed, km/h (mph)	n.a.	220-240 (136-149)	n.a.	n.a.	n.a.	n.a.
Normal cruise altitude, m (ft)	9,000-12,000 (29,500-39,370)	9,000-12,000 (29,500-39,370)	9,000-12,000 (29,500-39,370)	9,000-12,000 (29,500-39,370)	9,000-12,000 (29,500-39,370)	9,000-12,000 (29,500-39,370)
Service ceiling, m (ft)	n.a.	15,500 (50,850)	n.a.	n.a.	n.a.	n.a.
Take-off run, m (ft)	n.a.	850 (2,790) (5,580/6,825) ‡	1,700 (5,580) (5,580/6,825) ‡	1,800 (5,905)	1,700/2,080	1,700/2,080
Landing run, m (ft)	n.a.	450 (1,475)	1,000 (3,280)	1,000 (3,280)	900 (2,950) ‡	900 (2,950) ‡
Range with max. payload, km (nm)	3,650 (1,973)	4,000 (2,162)	4,400 (2,378)	4,200 (2,270) †	3,650 (1,973) §	3,650 (1,973) §
Max. range, km (miles)	n.a.	n.a.	n.a.	n.a.	n.a.	7,300 (4,530) ¶

* Including 90,000 kg (198,412 lb) in the wing tanks.

† Initially the IL-76MF's maximum payload was limited to 52,000 kg (114,638 lb); with this payload, maximum range is 5,200 km (2,810 nm).

‡ Some sources state the IL-78's take-off and landing run as 850 m and 450 m respectively

§ With 50,000 kg (110,229 lb) of payload.

¶ With 20,000 kg (44,091 lb) of payload.

IL-86 widebody passenger aircraft

The creation of the IL-86 – the first 350-seat widebody airliner in the USSR – became a qualitatively new stage in the work of the Ilyushin OKB's staff.

By the end of the 1960s the world's major airports became heavily overburdened due to the rapid growth in the volume of passenger air traffic. The holding time for aircraft arriving at an airport increased sharply, the intervals between take-offs and landings became accordingly shorter, and the unoccupied area of airports became smaller because they were crowded by aircraft and maintenance vehicles. Congestion at airports entailed complications for ground maintenance of airliners and was also detrimental to flight safety due to the difficulties of managing the traffic of a big number of airliners in the airport area. These problems and the need to ensure a further growth of the volume of passenger traffic prompted aircraft designers to seek new ways when projecting prospective passenger aircraft.

Project studies undertaken in many design bureaux showed that the above-mentioned problems could be addressed by developing and putting into operation high-capacity airliners designed to carry 250 to 500 passengers. This would make it possible to reduce the number of aircraft required to cope with a given volume of traffic and would ensure more efficient use of aircraft and their maintenance. Most importantly, this would enhance the safety of airliner operation by reducing the number of take-offs and landings in airports with the highest traffic density. In addition, high-capacity airliners would ensure lower operating costs, including the fuel burn per seat-mile. This, in turn, would make it possible not only to recover the expenses involved in projecting, development and construction of the necessary fleet of airliners, but also to reduce the operating costs and, in consequence, to eventually increase the volume of passenger traffic.

As is well known, the aircraft manufacturing companies in the USA were the first to set about the development of high-capacity airliners. In the Soviet Union design work on such aircraft (known locally as *airbuses*) started in 1969. As mentioned earlier, the first time the Ilyushin OKB attempted to create a high-capacity airliner was the emergence of a project of the IL-62M-250 airliner designed to carry 250 passengers. In the course of further studies undertaken jointly with the research organisations of MGA on the basis of numerous investigations and with due regard to scientific forecasts of the growth of passenger traffic in the USSR, a set of specifications was evolved defining the required performance characteristics of a high-capacity airbus. These included: a required runway length of 2,600 m (8,530 ft), a maximum capacity of 350 passengers, a practical range of 3,600 km (2,237 miles) with a 40-tonne (88,200-lb) payload and 5800 km (3,605 miles) with a 20-tonne (44,100 lb) payload, and a cruising speed of 900 km/h (559 mph). Some other requirements were also stipulated for the aircraft, taking into account the situation in Aeroflot's ground maintenance facilities and runway condition in airports from which this aircraft was expected to operate. Among such special requirements were: implementation of the 'carry-on baggage plus containers' principle; providing the aircraft with three passenger doors with built-in airstairs obviating the need for mobile gangways, to say nothing of boarding fingers which were just beginning to be introduced at Soviet airports; and, finally, the possibility of operating the aircraft from Soviet B-class paved air-

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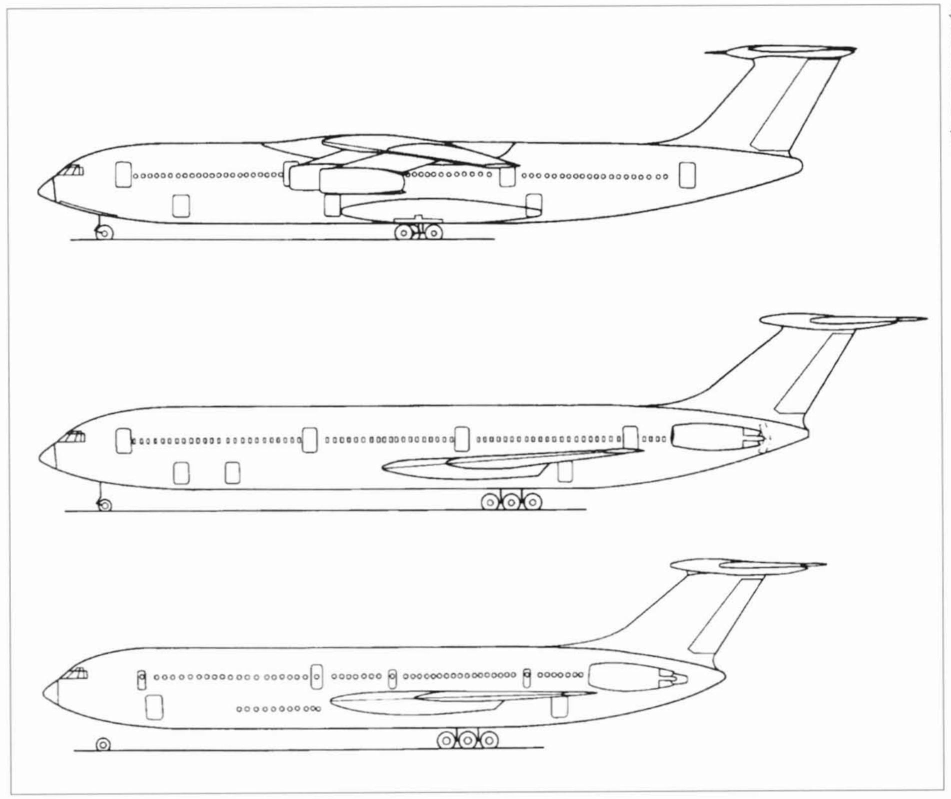
Top and above: This project configuration of the IL-86 of 1971 envisaged aft-mounted engines and a T-tail. This configuration was ultimately rejected in favour of podded engines under the wings. Note the nose shape.

Sergey and Dmitry Komissarov archive

An artist's impression of the IL-86 as it looked at the final stage of the design process.



Ilyushin Aircraft Complex

Above: Three consecutive preliminary design project versions of the IL-86 – a high-wing airliner, a low-wing single-deck layout and a low-wing double-deck layout with a shorter fuselage. All three versions featured integral airstairs

fields with the runway pavement equivalent to a C-class airfield (that is, with a lower bearing strength).

On 8th September 1969 the CofM Presidium's Commission on Defence Industry Matters took the decision to task the Ilyushin's OKB with the development of the IL-86 widebody passenger aircraft. On 22nd February 1970 the OKB received a specific operational requirement for the development of a 350-seat 'airbus'. In accordance with its traditions, the OKB conducted the work on projecting a new-generation aircraft in a comprehensive way, with due regard to enhanced requirements regarding the aircraft's reliability, economic efficiency and passenger catering standards. The need to meet the aforementioned requirements determined the basic layout and structural configuration of the future aircraft which was designated IL-86. To begin with, the stipulated seating capacity necessitated a whole set of studies associated with selecting the optimum cross-section of the cylindrical part of the fuselage; it was also necessary to develop such an arrangement for passenger accommodation and baggage/cargo stowage that would most efficiently correspond to the conditions of the airliner's operation and would meet an eventual increase in the number of passengers in the future. To accommodate 350 passengers, it was necessary to increase considerably the number of seats per row in the cylindrical part of the fuselage. The designers sought to retain the level of comfort that had been achieved in narrow-body airliners while minimising the weight penalty associated with the increase in the fuselage's dimensions. These considerations led them, when preparing the first project versions of the IL-86, to study the options of double-deck fuselages with passenger cabins on the upper and lower decks, as well as single-deck fuselages with a horizontal-oval cross-section featuring two separate passenger cabins with five-abreast single-aisle seating. Subsequent studies showed that, given the same seating capacity, these fuselages offered no advantages in aerodynamics and weight over the single-deck circular cross-section fuselage with a twin-aisle cabin. Moreover, the use of fuselages featuring a vertical or horizontal oval cross-section entailed considerable weight penalties due to the necessity to introduce new structural elements. It would also be difficult to ensure rapid passenger evacuation from such cabins, especially in the case of crash landings of aircraft with a double-deck fuselage layout.

For an aircraft with a 350-passenger seating capacity the use of a circular-section fuselage accommodating all passengers on a single wide deck made embarkation and disembarkation of passengers considerably easier. It was also relatively easy to ensure emergency evacuation of passengers from such a fuselage within the time limits stipulated by airworthiness standards. The lower part of such a fuselage could accommodate standard LD-3 type ABK-1.5 baggage containers (*aviatsionnyy bagahzhnyy konteyner*); alternatively, one could outfit the aircraft in accordance with the 'carry-on baggage plus containers' system which was expected to be incorporated in the IL-86. The main advantage of the circular-section fuselage, however, consisted of providing the possibility for creating a new, higher level of comfort. This would not only increase the widebody aircraft's passenger appeal but also increase the airliner's economic efficiency and hence its competitiveness.

The diameter of the IL-86's circular-section fuselage was determined with a view to meeting a number of requirements. Apart from obtaining an optimum combination of the fuselage's weight and aerodynamic characteristics, the chosen cross-section should ensure as many variations as possible in the number and distribution of seats abreast. Due regard also had to be taken to the possibility of further developing the IL-86 – both with a view to increasing the number of seats and for the purpose of converting it into a cargo version accommodating standard aircraft cargo pallets and containers on its upper deck. Proceeding from a prior set of studies, the designers selected for the IL-86 a fuselage measuring 6.08 m (19 ft 11⅜ in) in diameter which afforded a nine-abreast twin-aisle seating arrangement (3+3+3). The use of twin-aisle seating ensured greater comfort for passengers and for cabin personnel, reducing the time required for passengers to take their seats and for attending to passengers. When projecting the IL-86, the width of the aisles was chosen taking into account the experience gained in the operation of widebody aircraft abroad.

The fuselage cross-section of the IL-86 determined many special features of its passenger cabin configuration. However, its layout was influenced especially strongly by the expected conditions of airliner operations and, above all, by the need to simplify as much as possible the passenger check-in procedure at airports through the implementation of a new approach to solving the problem of baggage transportation and its stowage in the aircraft. This task was solved in conjunction with a whole number of other problems pertaining to operation, weight and aerodynamics. Among other things, a comparison of different baggage stowage options was made at the preliminary design project stage. For example, an arrangement was studied providing for each passenger keeping his baggage literally at his side – that is, beside the seat, under the seat or in an overhead baggage bin. However,

Ilyushin Aviation Complex

Above: CCCP-86000 (c/n 01-01), the IL-86 prototype, undergoes maintenance at the Ilyushin OKB's experimental shop at Moscow-Khodynka. Note the wider-than-usual spacing of the characters in the Aeroflot titles, a result of the No.2 pair of main deck doors encroaching on the titles.

analysis of this version showed that, even if one chose a double-deck layout, the fuselage length would be more than 3 m (9 ft 10 in) greater compared to a variant providing for separate accommodation of the passengers and their baggage on the upper and lower deck respectively. Another major drawback was that stowing all the baggage in the passenger cabin created a risk of damaging some elements of the interior and catering equipment by loose items of baggage; it would also considerably hamper passenger evacuation in an emergency.

Therefore, from then on the studies of possible cabin layouts for the IL-86 envisaged only separate accommodation of passengers and baggage. As a result, the designers opted for a layout retaining the established arrangement as regards passenger, baggage and cargo accommodation; it was based on the 'carry-on baggage plus containers' principle.

The main feature of this layout consisted of the provision of three compartments fitted with shelves at the lower deck level. There were three built-in airstairs on the port side; their width and slope enabled passengers to enter the aircraft, carrying their baggage in their hands. The baggage was then placed on the shelves of the baggage/cargo compartments. These compartments were connected with the main deck by internal single-flight stairs with a width that afforded the movement of passengers two abreast. The three stairs were located at equal distances along the whole length of the passenger cabin; each of them led into one compartment of the passenger cabin (forward, centre and aft). The compartments were separated from each other by galleys and transverse passages to the emergency exits. Thus, the main special feature of the IL-86's cabin consisted of its division into three separate sections distributed evenly along the length of the aircraft. Thanks to this all passengers were divided into relatively small groups that were easy to attend to; in case of need they could be speedily organised for emergency evacuation. The twin-aisle arrangement of seats speeded up the distribution of meals to passengers and ensured unimpeded passage of cabin attendants and passengers from any place in the cabin to the seats, toilets and emergency exits. The cabin had four ICAO Type Ia doors/emergency exits on each side which were provided with inflatable two-track slides enabling the passengers to abandon the aircraft two at a time.

The adopted layout of the IL-86's passenger cabin and baggage/cargo compartments based on the 'carry-on baggage plus containers' principle gave the airliner certain operational advantages. Among other things, the IL-86 could be put into scheduled service without refurbishing the existing airport buildings for the purpose of increasing their passenger handling capacity and with-

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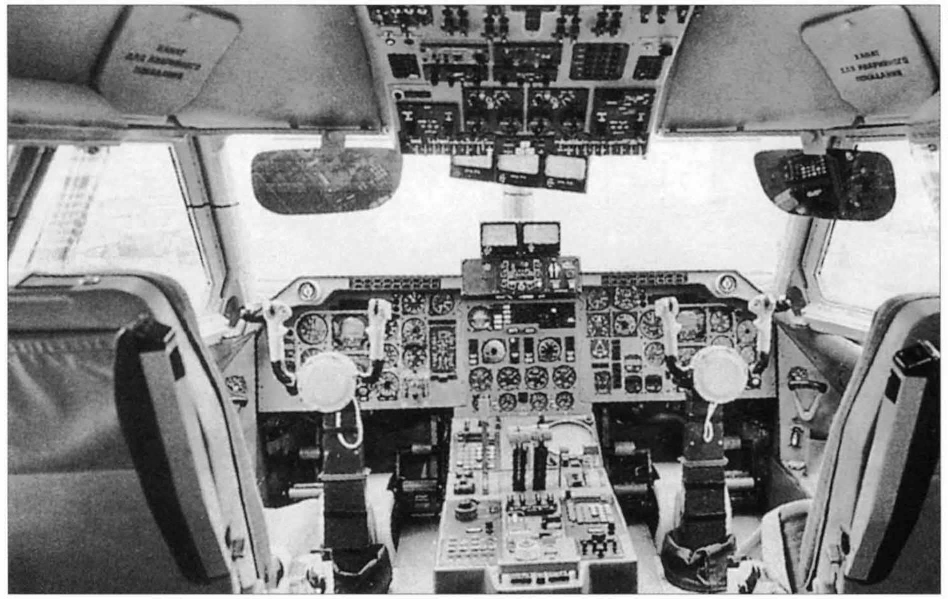
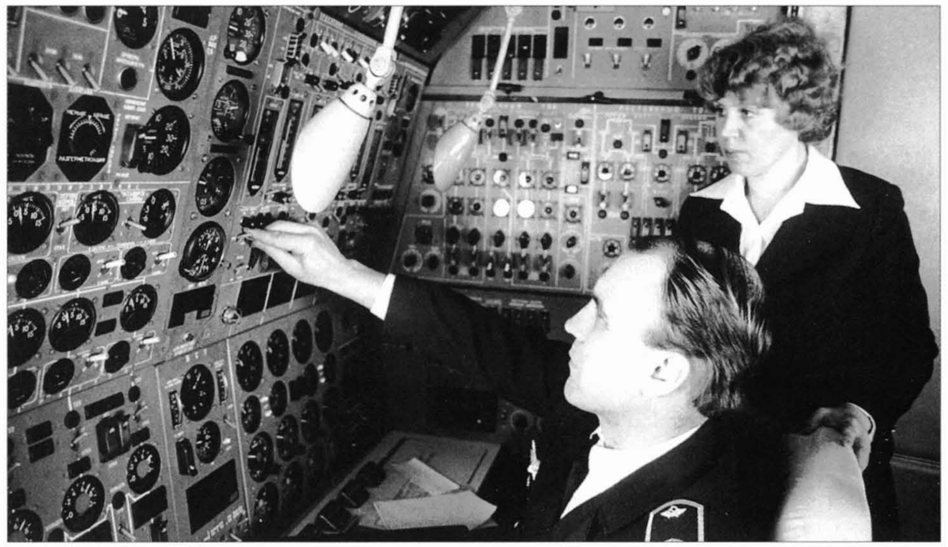
The IL-86 prototype at Khodynka in December 1971 shortly after the rollout. Note the non-standard rendering of the 'IL-86' nose titles (in italics).



Above: The flightdeck of the IL-86 prototype. Note the round 'boxes' on the control wheel hubs are part of the test instrumentation; so are the instruments on top of the main instrument panel shroud.



Above: The flight engineer's station of the IL-86, with gooseneck lamps to provide lighting.

A look inside the flightdeck of an in-service IL-86; note the different type of seats.

out introducing special automated systems for processing and transporting a large amount of baggage to the places of its loading into containers and to the baggage reclaim areas after the flight. In addition, the 'carry-on baggage plus containers' system considerably reduced the passenger check-in time and the time required for baggage loading and reclaim. The number of man-hours needed for passenger service at airports was cut by 50% and the required number of attending personnel was also greatly reduced. So was the turn-around time, which had a direct influence on the aircraft's economic efficiency; the real speed of the passengers' air travel was increased, and their baggage was better protected against loss – or theft. A contributing factor to the IL-86's high operational efficiency was the use of its built-in airstairs which allowed the aircraft to operate into poorly equipped airports and considerably reduced the time that the aircraft had to sit on the ground.

On 9th March 1972 the Council of Ministers issued a directive ordering the commencement of work on the IL-86 widebody airliner powered by Solov'yov D-30KU turbofans. Flight testing was slated to begin in 1976. Initially the project envisaged placing the engines in pairs on the aft fuselage in combination with a T-tail (as on the IL-62); only after the lapse of three years that were spent on preparing the advanced development project did it become clear that these engines would not provide the necessary take-off performance with a full gross weight under conditions when one of the critical (outboard) engines became inoperative. All that the Soviet aircraft industry could offer at the time was the Kuznetsov NK-86 turbofan which was a direct 'descendant' of the NK-8; it had a take-off thrust of 13,000 kgp (28,665 lbst) at sea level and an ambient temperature of 15°C, with a fuel burn of 3 tonnes (6,610 lb) per hour in cruise flight. True, in Soviet times this was not of major importance – kerosene was cheap, and the 'airbus' was being designed primarily for domestic high-density routes. On 26th March 1975 a document amending the previous Council of Ministers directive was issued; it kicked off the development of the IL-86 version powered by NK-86 engines.

When selecting the aircraft's layout on the basis of comparative analysis and experience amassed by the Design Bureau, a high-wing configuration similar to the IL-76 was proposed initially. Eventually, however, the designers opted for the low-wing configuration nacelles which had already become traditional for widebody airliners abroad, with swept wings and four NK-86 engines in individual underwing. The aerodynamic configuration was determined by a number

Above: The IL-86 prototype taxies at Moscow-Khodynka in December 1971 during ground tests with the flaps and slats fully deployed.

of theoretical and experimental studies aimed at obtaining a high lift/drag ratio and the required lift characteristics, as well as good stability and controllability characteristics in all predictable operational conditions.

Studies conducted jointly with TsAGI on the selection of the most efficient aerodynamic configuration of the IL-86's wings resulted in a wing design featuring 35° sweepback at quarter-chord. In conjunction with the fuselage measuring 6.08 m (19 ft 11⅜ in) in diameter and possessing high aerodynamic perfection these wings gave the aircraft a high lift-drag ratio at a cruising speed of Mach 0.82, as well as in take-off and landing modes. Selection of the type of high-lift devices was also accompanied by a large volume of research and development which made it possible to meet stringent requirements concerning the aircraft's operations from relatively short runways. As a result of comprehensive research work the the IL-86 came to feature slats and triple-slotted flaps with a fixed deflector and deflectable trailing-edge segment without moving the segments apart.

A high level of flight safety, passenger comfort, high operational efficiency and ease of manufacture were ensured by a number of design features, the innovative character of which was confirmed by 130 patents.

The IL-86 was to be equipped with the latest automatic piloting and navigation systems; this would permit the crew of three to perform flights on domestic and international routes under all climatic and geographical conditions, at any time of the year and round the clock, strictly adhering to schedules. A high degree of passenger comfort was ensured by comfortable seats, the use of the latest catering equipment and advanced forms of passenger service. Placing the main elements of the galley equipment under the cabin floor, with only refreshment bars at the

The captain of an IL-86 discusses the flight route with the navigator; note the cockpit detail.

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Top and above: The IL-86 was the first Soviet airliner to use LD-3 type baggage containers. Here, ABK-15 containers are loaded into the forward baggage compartment of an Aeroflot example; note the Ilyushin logo.

main deck level, made it possible to use the passenger cabin area rationally. The use of catering trolleys speeded up the distribution of meals to passengers and considerably reduced the flight attendants' workload.

Many novel features were incorporated into the IL-86's airframe design. These included stamped and bonded/riveted panels, large-size stamped parts, honeycomb structures, composite materials, various types of titanium attaching parts, improved rivets, new methods of imparting extra strength to structural elements and many other things. All this necessitated the development and introduction into series production of new manufacturing technologies. Later, when the airliner had entered production, more than 50 new production methods were introduced at the Voronezh aircraft plant No.64 which built it; these included adding extra strength to metals by means of electrochemical processes, honeycomb structures, composite materials and so on. Instead of the usual AMG oil-type hydraulic fluids the hydraulic systems made use of the special NGZh fluid which, although toxic, was non-flammable (hence the acronym meaning *negoryuchaya ghidravlicheskaya zhidkost'* – non-flammable hydraulic fluid); the navigation equipment even comprised a sort of flight computer.

The IL-86 proved to be an epoch-making aircraft for the USSR. For the first time there was an airliner under development in the Soviet Union that would provide a degree of comfort on a par with world standards – and not only for the passengers but also for the flight and cabin crew and, to some extent, for the ground personnel. For the first time the flightdeck interior and ergonomics did not resemble those of a bomber, for the first time the passenger cabin with its nine-abreast, twin-aisle seating offered a lot of headroom (cabin height was 2.5 m / 8 ft 2½ in), and meals for passengers were prepared on the lower deck and sent to the main deck with the help of a special lift.

Construction of the first prototype, registered CCCP-86000 (c/n 01-01), was a co-operative effort involving many enterprises of the country which supplied various parts, units and subassemblies. Upon completion of this work, on 22nd December 1976, the prototype took to the air for the first time. The aircraft was captained by Merited Test Pilot, Hero of the Soviet Union Eduard I. Kuznetsov; the crew also included first officer G. N. Volokhov, navigator V. A. Shchotkin and flight engineer I. N. Yakimets. After taking off from Moscow-Khodynka the aircraft was ferried to the flight test facility at the LII airfield in Zhukovskiy where its manufacturer's flight tests began.

In June 1977 the first prototype IL-86 made its international debut at the 32nd Paris Airshow, attracting much attention and receiving a high appraisal from foreign aviation experts (and the NATO reporting name *Camber*). The aircraft was flown by a crew captained by E. I. Kuznetsov, with V. S. Krooglyakov as project engineer.

On 6th June 1977 the IL-86 completed Stage A of its certification tests; the manufacturer's trials of the IL-86 as a whole were successfully completed on 20th October 1978, two months ahead of schedule. These tests were used to determine the aircraft's performance (the prototype attained a speed of Mach 0.93) and appraise the stability and handling characteristics. The latter were also checked at high angles of attack exceeding by 11° the angle of attack prescribed for the normal operation of the aircraft; hence CCCP-86000 was equipped with a spin recovery parachute replacing the APU in the fuselage tailcone.

Despite a high fuel burn, with a full payload the IL-86 had a range of 3,600 km (2,237 miles) with some fuel reserves remaining, and its range with a reduced payload amounted to 5,500 km (3,418 miles); these figures were attained during flights with a fairly high cruising speed (Mach 0.8-0.81). The extremely efficient high-lift devices made it possible to bring the landing approach speed to 260-280 km/h (162-174 mph) and make use of runways 2,600 m (8,530 ft) long. The manufacturer's trials also gave an opportunity to determine the characteristics of the NK-86 engines during flights in different modes, to appraise the functioning of powerplant systems and of the aircraft's systems and equipment.

The second prototype registered CCCP-86001 (c/n 01-02; this was the first Voronezh-built example) took to the air on

Ilyushin Aviation Complex

Above: IL-86 CCCP-86000 seen during a test flight. Note the angle which the centreline main gear bogie assumes in no-load condition.

24th October 1977, with captain Eduard I. Kuznetsov and first officer Hero of the Soviet Union, Merited Test Pilot A. I. Voblikov at the controls. The third IL-86 (CCCP-86002, c/n 01-03) was first flown on 2nd March 1979 by the same crew; this was, in effect, the first production machine.

Before the end of 1978 a fairly large number of demonstration flights were performed by the two prototypes. On 23rd April 1978 the first prototype, CCCP-86000, was ferried to Sochi/Adler airport at the Black Sea coast (captain E. I. Kuznetsov, project engineer V. S. Krooglyakov). Between 29th September and 1st October of that year the aircraft made demonstration flights to Mineral'nyye Vody, Adler and Simferopol, flown by the same crew. Stage B of the aircraft's certification tests was officially completed on 22nd November. Between 10th and 25th December a new series of demonstration flights

ITAR-TASS

CCCP-86002, the first production IL-86 (c/n 01-03), is rolled out at Voronezh-Pridacha, the Voronezh Aircraft Production Association airfield, in 1972. The bullet fairing on the fin is probably part of the test instrumentation.

Yefim Gordon archive

ITAR-TASS

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Views inside the spacious cabin and the lower-deck galley of the IL-86.

took place; these were performed by the second prototype (CCCP-86001) to Leningrad, Rostov-on-Don and Novosibirsk. The crew was captained by Stanislav G. Bliznyuk, with Yu. M. Arandt as project engineer.

On 24th April 1979 Minister of Civil Aviation Boris P. Boogayev signed an order authorising the commencement of the IL-86's State Acceptance trials. V. Ch. Mezokh, a test pilot from GosNII GA, was appointed project test pilot. One month later, on 29th May, the manufacturer's test stage was finally completed by signing an appropriate document; as for the State acceptance trials, they were successfully completed on 9th September 1980. In the course of the State acceptance trials the aircraft performed 680 flights, logging a total of 1,293 hours and 13 minutes. These tests demonstrated that the Ilyushin OKB had created an airliner that was superior in operational efficiency to other types of Soviet passenger aircraft operated on medium-haul routes. The IL-86 ensured a considerable reduction of operating costs and made it possible to save a sizeable amount of fuel.

In June 1979, while being engaged in the State Acceptance tests, the first prototype went to Le Bourget again, participating in the 33rd Paris Airshow (it was flown by E. I. Kuznetsov and A. M. Tyuryumin).

On 23rd September 1979 the third production example (and the fifth aircraft built) registered CCCP-86004 (c/n 0002) was ferried from Voronezh to Moscow/Vnukovo-1 airport (crew captain V. A. Kalimanov). Four days later, on 27th September, service trials were initiated in the Moscow Territorial CAD/Vnukovo UAD/65th Flight with two IL-86s registered CCCP-86003 (c/n 0001) and CCCP-86004. On 10th December 1980 a route proving flight was undertaken on the Moscow to Mineral'nyye Vody and return route, followed on 12th December by a flight to Tashkent and back. The operational trials of the airbus were completed on 18th December 1980; at their final stage they involved all five IL-86s that had been built by then. In all, 490 flights had been performed and 1,221 hours and 49 minutes of flying time logged. After the completion of these trials the first prototype (CCCP-86000) was ferried to the Kiev Institute of Civil Aviation Engineers (KIIGA) where still serves as an instructional airframe.

On 24th December 1980 the State Aviation Register of the USSR issued to the Ilyushin OKB a type certificate for the IL-86 widebody passenger aircraft, certifying that the airliner met the NLGS-2 airworthiness standards for Soviet civil aircraft. A flight on the Moscow-Tashkent route inaugurated the IL-86's scheduled services on the country's domestic air routes.

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Above: CCCP-86003 was the first IL-86 to perform revenue services. It is now a ground instructional airframe at Moscow/Sheremet'yevo-1

On 1st February 1981 an independent flight of the IL-86 widebody airliner was set up in the Central Directorate of International Services (TsUMVS), subsequently becoming the 216th Flight; the unit was headed by V. I. Parshin. On 22nd April 1981 a group of Ilyushin OKB engineers that had been engaged in designing the aircraft (G. E. Dolgushev, M. M. Kiselyov, G. K. Nokhratyan-Torosyan, P. N. Belyanin, I. S. Razumovskiy, and R. Ye. Shalin) was awarded the Lenin Prize for the creation of the IL-86.

In the following year the IL-86 was put into operation simultaneously on several domestic and international air routes. On 3rd July 1981 the type performed its first international service on the Moscow-Berlin route (the aircraft was captained by V. D. Mishustin); on 12th October the IL-86 was introduced on the Moscow-Prague service, and on 25th October on the Moscow-Vienna route. Large-scale operations with the type were initiated. However, the list of destinations on domestic routes grew slowly – it turned out that airports and air terminals were not ready for handling the widebodies after all. Novosibirsk, Alma-Ata, Mineral'nyye Vody were the first cities to start receiving and dispatching the IL-86, and in Simferopol' a new runway had to be built.

The IL-86's heyday came in the late 1980s and the early 1990s. The relatively low fares and the liberalisation of laws governing travel to and from the USSR caused a burgeoning demand for air services both on the traditionally popular routes (to Sochi, Simferopol and Mineral'nyye Vody) and to destinations abroad (to Bulgaria, Turkey, Greece, Spain, Egypt, the UAE and Israel).

The high performance of the IL-86 was also acknowledged on the international scene. Between 21st and 24th September 1981 a crew captained by Merited Test Pilot G. N. Volokhov, Hero of the Soviet Union, established 18 international records in the IL-86. With payloads of 35, 40, 50, 60 and 65 tonnes (77,160; 88,180; 110,230; 132,275 and 143,300 lb) the aircraft attained an average speed of 971 km/h (603 mph) on a 2,000-km (1,242-mile) closed circuit. With a payload of 35 to 80 tonnes (77,160 to 176,370 lb) the IL-86 clocked a speed of nearly 956 km/h (594 mph) on a 1,000-km (621-mile) closed circuit. The increases in maximum take-off weight and payload attained in the record flights made it possible to discover the potential incorporated in the design of the first Soviet 'airbus', to study the behaviour of an aircraft with a large AUW when airborne and, in conjunction with the experience gained during scheduled services, to use the data obtained in record flights for a further development of the airliner and for broadening the scope of its use, as had repeatedly been the case with the IL-18, IL-62 and IL-76 aircraft.

On 5th November 1982 an IL-86 registered CCCP-86015 (51483202013) made its first flight in a 450-seat configuration on Moscow-Tashkent-Moscow route (captain G. N. Volokhov, project engineer A. V. Manokhin). Three years later this special version began scheduled services. (In the IL-86's c/ns, 514 appears to be a product code, 8 means this is the eighth post-war type built in Voronezh and 32 is a code for plant No.64, followed by the Voronezh batch number (?) and the sequential line number.)

On 5th November 1982 V. P. Bobrov, N. F. Makokin and B. M. Toolikov were awarded a State Prize for the introduction of the widebody airliner into series production.

On 30th May 1993 China Xinjiang Airlines took delivery of the first of the three IL-86 aircraft ordered by that country. These were the type's only export sales.

The outlook for the IL-86 changed in the late 1990s. Firstly, a severe blow was dealt to the mass tourism by the Russian bank crisis

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IL-86 CCCP-86002 is prepared for another flight.

Aviatsiya i Kosmonavtika

Above: CCCP-86067 (c/n 51483204034), a TsUMVS/216th Flight IL-86, on final approach to Moscow-Sheremet'yevo.

Dmitriy Petrochenko

Above: Supporting the colourful basic livery of Armenian Airlines, IL-86 EK-86117 (c/n 51483209085) leased by Atlant Soyuz taxies out for take-off at Moscow/Sheremet'yevo-2 in 1999. It has since been returned.

Dmitriy Komissarov

Above: IL-86 UK 86053 (c/n 51483202020) of East Line awaits the next flight at Moscow-Domodedovo on 20th October 1998; the aircraft retains the colour scheme of the lessor, Uzbekistan Airways.

Yuriy Kirsanov

Above: Aeroflot Russian International Airlines IL-86 RA-86058 (c/n 51483203025) at its home base. It later received a grey tail, as was standard on ARIA's IL-86s.

Dmitriy Komissarov

AJT Air International IL-86 RA-86065 (c/n 51483203032) is towed at Moscow/Sheremet'yevo-2 on 11th June 1999. Unlike most of the airline's aircraft, this one wore basic Aeroflot colours.

of 17th August 1998 ('Black Monday'); next, ICAO enforced new noise and pollution standards and operational procedures. By the late 1990s the available means of navigation became outdated; the use of GPS navigation receivers and traffic collision avoidance systems (TCAS, and then TCAS II) became obligatory. Finally, from 1st April 2002 onwards the IL-86 was barred from entering the airspace of most European countries by the new noise standards. As a result, the first Soviet widebody airliner became an aircraft for seasonal use – a 'holidaymaker's aircraft' serving a limited number of destinations.

To this day the IL-86's inadequate thrust/weight ratio remains, in effect, the only drawback of an aircraft that can generally be assessed as excellent. The IL-86 turned out to be the only Russian aircraft that suffered no crashes with passengers on board during more than 20 years of scheduled services. Owing to the high reliability of the NK-86 engines the cases of an engine cutting in flight were relatively rare, and the first serious incident with an in-flight engine fire (fortunately, it ended without serious consequences) happened only in the 20th year of the aircraft's airline operation. Two non-fatal accidents involving the type were utterly absurd. On 8th March 1994 a Sahara Indian Airlines Boeing 737-2R4C (VT-SIA) veered off the runway while performing a touch-and-go at New Delhi International airport, crashing into Aeroflot Russian International Airlines IL-86 RA-86119 which was being readied for the return flight to Moscow. Both airliners were destroyed by the ensuing fire, the Indian crew losing their lives. The other incident happened at Dubai on 21st September 2001, when another ARIA IL-86, RA-86074, made a belly landing because the crew, having switched off the landing gear warning horn because of the non-standard landing approach pattern, forgot to extend the undercarriage!

The first-ever fatal crash in the type's history occurred on 28th July 2002; Pulkovo Avia IL-86 RA-86060 stalled and crashed less than a minute after taking off from Moscow-Sheremet'yevo on a positioning flight to St. Petersburg due to incorrectly set stabiliser trim, killing most of the crew. A few hotheads raised an almighty anti-IL-86 campaign, demanding that the aircraft's type certificate be revoked because the aircraft was 'inherently unsafe', and there is speculation that the interests of certain airlines, not flight safety, were the main motive for these attacks. Fortunately wiser counsels prevailed, and the ensuing investigation cleared the aircraft completely.

IL-86 production totalled 103 aircraft; of these, in post-Soviet days 80 were operated by various Russian carriers, 7 by Kazakhstan Airlines (now Air Kazakstan), 10 by Uzbekistan Airways and 2 by Armenian Airlines. Three aircraft were delivered to China Xinjiang Airlines in 1993; however, all three were sold to Russia in 2003. The first Soviet airbuses served 19 destinations in Russia and other CIS countries, as well as 31 cities in 25 countries outside the CIS.

IL-80 (IL-86VPU) airborne command post

Emergence of the first Soviet large-size widebody airliner did not pass unnoticed by the Ministry of Defence of the USSR which tasked the Ilyushin OKB with developing a national emergency airborne command post (NEACP) based on the IL-86 (the Soviet equivalent of the Boeing E-4). It was designated IL-80, although some sources quote the designation IL-86VPU (*vozdooshnyy poonkt oopravleniya* – ABCP).

Design work on the airborne command post intended for troop control was conducted under conditions of utmost secrecy in the first half of the 1980s. The main difficulties consisted of accommodating the heavy and bulky mission equipment (it was based on outdated Soviet electronic components) on board the aircraft within the existing AUW limitations, and in creating a system for the cooling of this equipment. Eventually the problems were successfully solved.

Outwardly the IL-80 differed in lacking the cabin windows, the two centre pairs of doors and two of the three integral airstairs (only the foremost ones were retained). A characteristic large canoe fairing (dubbed 'hump') on top of the forward fuselage, and several large aerials (including a trailing wire aerial) were added. Two large pods housing powerful generators driven by gas turbine engines were carried on pylons under the wing roots, and an in-flight refuelling probe was fitted on the port side of the nose.

The IL-80 prototype made its first flight on 29th May 1985. State Acceptance trials conducted on five aircraft – the prototype and four production examples (CCCP-86146 through -86149, now RA-86146 through -86149) showed that the aircraft fully met the specification requirements.

At first the aircraft were based at the LII's airfield in Zhukovskiy. After acceptance by the Soviet Air Force they were transferred to Chkalovskaya AB near Moscow.

IL-86 'Filin' (IL-86SOLF) flying ophthalmic surgery clinic (project)

In the second half of the 1980s the Ilyushin OKB began development of a 'flying hospital' version of the IL-86 airliner. The work was initiated in response to a technical specification issued by the internationally renowned


Dmitriy Petrochenko

IL-86 RA-86105 (c/n 51483208073) displays the stylish livery of Sibir' Airlines at Novosibirsk-Tolmachovo.

Yefim Gordon archive

Above: RA-86139 (c/n 51483210098) was operated by Atlant-Soyuz in 1999 in basic Aeroflot colours. It had the airline's tail logo and small Aviakompaniya pravitel'stva Moskvy (Moscow Government airline) subtitles.

Dmitriy Komissarov

Above: Kras Air IL-86 RA-86121 (c/n 51483209089) awaits the next load of passengers at Moscow-Domodedovo on 20th October 1998. So far only one of the airline's IL-86s, RA-86122, carries full colours.

Yuriy Kirsanov

Above: Seen here taking off at Moscow-Sheremet'yevo, RA-86115 (c/n 51483209083) was briefly operated by Orient Avia. After the airline's bankruptcy in 1997 the aircraft was taken over by AJT Air International.


Dmitriy Komissarov

The end of the road for Vnukovo Airlines. RA-86082 (c/n 51483206053), one of its IL-86s, sits engineless at Moscow/Vnukovo-1 on 6th May 2003.

AVICO-Press

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AVICO-Press

Three views of CCCP-86147, the second of five IL-80 (IL-86VPU) airborne command posts. The dorsal 'hump', the four huge blade aerials, the strake ahead of the fin, the IFR probe and the underwing turbine power packs are clearly visible, as is the lack of cabin windows and the doors immediately ahead and aft of the wings.

Ophthalmic Microsurgery Institute headed by Academician Svyatoslav N. Fyodorov, and was financed by this Institute. The idea was to turn the aircraft's cabin into a sort of surgical ward – the Soviet counterpart of the American DC-10 Orbis, which would enable the Institute's specialists to perform unique ophthalmic surgery operations in remote areas of the Soviet Union, thereby benefiting those who were not in a position to come to Moscow for that purpose.

Joint efforts of the OKB specialists and the Ophthalmic Microsurgery Institute resulted in the preparation of an advanced development project of the 'flying surgical ward' which was dubbed Filin (Eagle owl); the aircraft is referred to in some sources as the IL-86SOLF (*spetsializeerovannyy oftal'mologicheskiy letayushchiy filiahl* – specialised ophthalmic [surgery] flying branch office). However, the tragic death of the Institute's leader in a helicopter crash on 2nd July 2000 and the lengthy economic crisis following the break-up of the Soviet Union put an end to further work on this project.

IL-86M widebody airliner (project)

As noted earlier, the design of the IL-86 offered wide opportunities not only for creating various specialised versions but also for perfecting the characteristics of the baseline model. In the course of series production at the Voronezh aircraft plant the OKB designers and the plant's specialists succeeded in reducing the airframe weight by 1.5 tonnes (3,310 lb) and in increasing the take-off weight by nearly 10 tonnes (22,050 lb), thus bringing it to 215 tonnes (474,075 lb). However, the aircraft lagged very much behind its Western counterparts as regards a very important parameter – the fuel burn.

After the dissolution of the Soviet Union greater emphasis was placed in Russia on international co-operation. This made it possible not only to attract sorely needed investments into the country but also to gain access to modern technologies. The emerging new possibilities prompted the idea of fitting the IL-86 with engines of foreign manufacture because operating the aircraft with the outdated NK-86 engines gradually became problematic not only outside the country but also on domestic routes. The engines in question were the CFM56-5C turbofans manufactured by the CFM International consortium; they had a take-off rating of 14,160 kgp (31,220 lbst) and a cruise SFC of 0.56 kg/kgp·h (lb/lbst·h).

The specialists of the Ilyushin Aviation Complex worked out all the necessary documentation, and the Voronezh Aircraft Production Company even conducted tooling-up for the manufacture of 20 updated IL-86M aircraft. However, the improved airbus never reached production status – this ran counter to the interests of certain circles acting as lobbyists for foreign aircraft companies in Russia.

Structural description of the IL-86

Type: Medium-range high-capacity airliner. The airframe is of all-metal construction.

Fuselage: Circular-section monocoque structure of 6.08 m (19 ft 11⅜ in) diameter with a frame-and-stringer structure. Its stressed skin is made up of large-size panels. Joints are mostly riveted or bonded. The fuselage is built in four sections, three of which form the pressurised portion between frames 1-90; outside the pressurised part of the fuselage are the cutout for the wing centre section, the pressurisation/air conditioning equipment bays and the wheel wells. The main deck accommodates the flightdeck, three passenger cabins for 110, 141 and 99 passengers respectively, eight vestibules with ICAO Type Ia plug-type doors/emergency exits (the Nos 1 and 2 port side doors are used for passenger embarkation/disembarkation through boarding fingers), two coat closets, eight toilets and two meal delivery counters. The lower deck houses two baggage holds with upward/outward-opening doors to starboard and adjustable partitions, a galley with a lift and a service door to starboard, three entry lobbies with hydraulically actuated integral port side airstairs, an avionics bay and two equipment bays. The decks are connected by three stairs and the lift shaft. The mutual arrangement of the passenger cabins, doors and stairs makes it possible to divide passengers into three flows not intersecting with each other and reduce by a factor of three the time needed for embarkation and disembarkation. The unpressurised rear fuselage section (frames 90-107) houses a bay for the control actuators, a cutout for the tailplane centre section and the APU bay.

To aid visual inspection of the wings and engines in flight, two floodlights are fitted near the No.1 main deck doors. All doors are fitted with a warning system indicating the open position of doors and locks, as well as with electrical interlocking devices preventing the doors from being opened when the pressure differential exceeds 0.98 kPa.

Wings: Cantilever low-wing monoplane of basically trapezoidal planform, with a kinked trailing edge; sweepback at quarter-chord 35°, dihedral 6.8° to ensure maximum clearance between the engine air intakes and the ground, aerodynamic camber +3°, geometrical camber –1°. The wings are three-spar structures. The high-lift devices comprise six-section leading-edge slats, two-section double-slotted extension flaps with a fixed deflector, air brakes and spoilers. Two-section ailerons are located outboard of the flaps, with four-section spoilers ahead of the outboard flaps. Three sections of spoilers can be used in the braking, roll control and combined modes; the fourth section for roll control only. Placed between the third spar and a stressed beam are attachment points for the port and starboard main undercarriage units. Two boundary layer fences are provided on each wing.

Tail unit: Conventional cantilever swept tail surfaces. Stabiliser incidence can be adjusted electrically between +2°/+12°; the stabiliser control buttons are placed on the pilots' control wheels and can be used for balancing the aircraft. The rudder and elevators are each built in two sections with separate hydraulic actuators.

Landing gear: Hydraulically retractable four-unit type, with free-fall extension in an emergency. The forward-retracting steerable nose unit has twin 1,300 x 480 mm (51.11 x 18.89 in) KT-185 brake wheels with an automatic braking feature used during retraction. The main gear consists of two wing-mounted units retracting inwards into the wing/fuselage fairing and a forward-retracting centre unit located further aft so that the three mainwheel wells are located in line. All three have four-wheel bogies with KT-171 wheels having the same size; they are equipped with electric brake cooling fans and RPM sensors installed inside the wheels. When extended, the centre main gear bogie protrudes downwards slightly more than the side bogies, assuming a nose-up attitude.

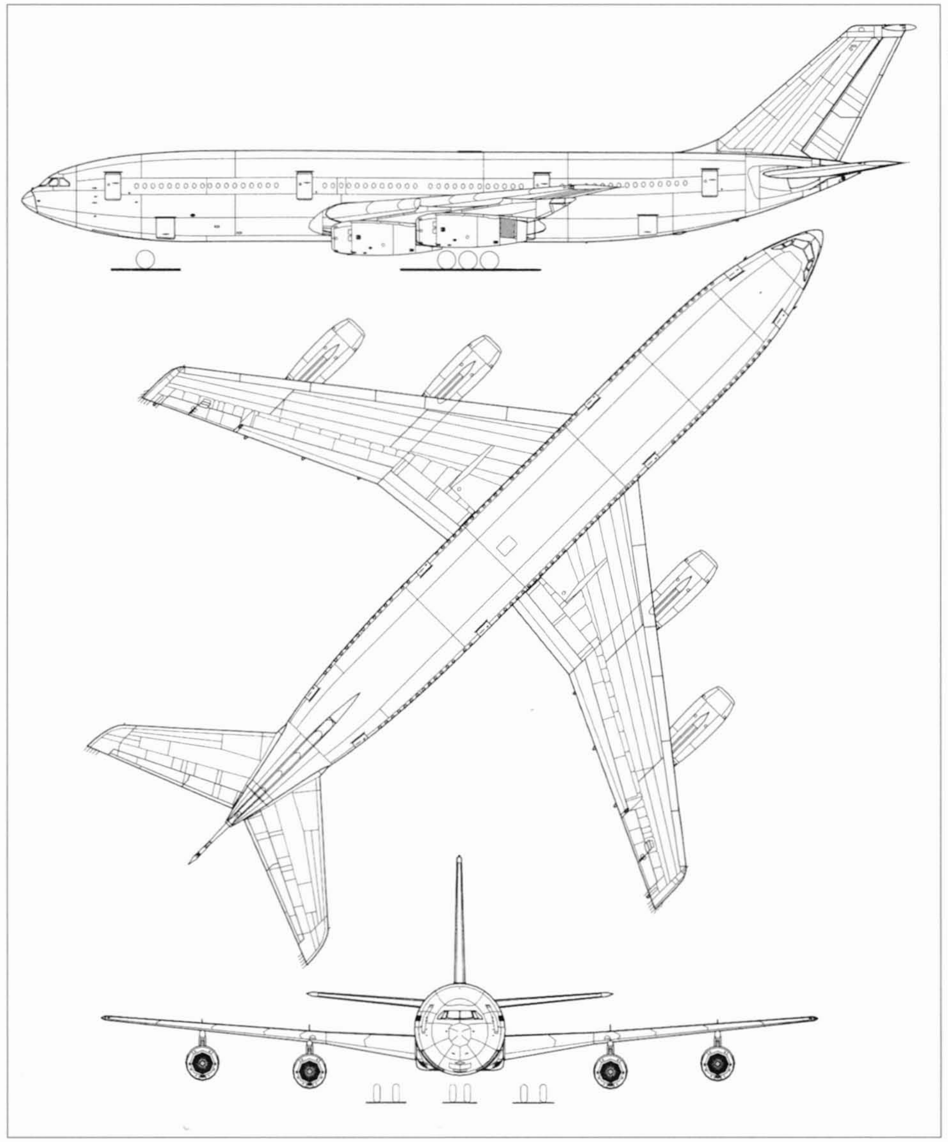
The centreline wheel wells are closed by two pairs of lateral doors each, while the port and starboard main units each have a fuselage-mounted door and a narrow door attached to the oleo. The large doors on all units open only when the gear is in transit.

Powerplant: Four Kuznetsov NK-86 turbofans rated at 13,000 kgp (28,665 lbst) for take-off. The NK-86 is a two-spool turbofan with a five-stage LP compressor (the first two stages act as a fan), a six-stage HP compressor, an annular combustion chamber, a single-stage HP turbine, a two-stage LP turbine and a cascade thrust reverser.

The engines are mounted in individual nacelles on pylons well ahead of the wing leading edge, acting as anti-flutter weights. To prevent foreign object ingestion during taxying, jets of air bled from the engine compressors are used to blow away dust and pebbles ahead of the air intakes. This sys-

Sergey Komissarov

This model displayed at MosAeroShow '92 represents a projected version of the IL-86 re-engined with CFM56-5C turbofans.



Via Polygon Press

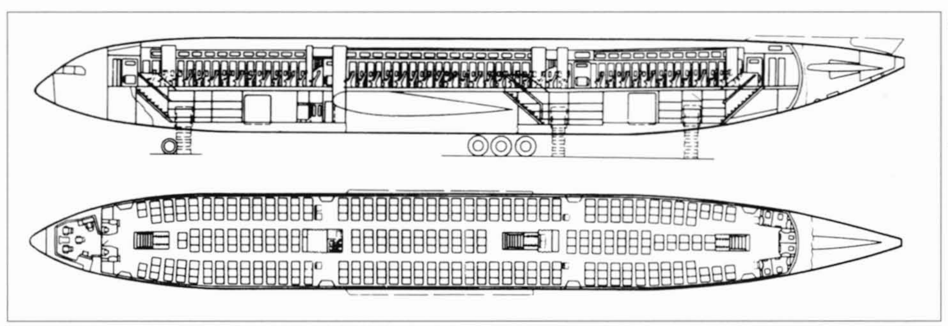
A three-view of the IL-86.

tem must be switched off at line-up to avoid draining the take-off thrust.

A VSU-10 APU is located in the fuselage tailcone for engine starting and ground power supply/cabin air conditioning The engines can also be started by air cross-bleed from another engine or from a ground source of compressed air. In-flight restarting is effected by windmilling.

All fuel is carried in the wings. The maximum fuel load is 86 tonnes (189,630 lb).

Control system: Hydraulically powered controls; the actuators are fed by four independent hydraulic systems. The SAU-1T-2 automatic flight control system (AFCS) enables both automatic and manual control modes. The need to use an AFCS while piloting in the manual mode is due to the aircraft's excessive directional stability caused by the pronounced wing dihedral, and to the necessity to damp transitional processes, especially during flight in turbulence. The system is extremely convenient in use, making it possible to perform the whole flight in the automatic mode. The climb can be stabilised both at constant airspeed and at constant vertical speed. The AFCS permits ICAO Cat II automatic approach.



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The internal layout of the IL-86, showing the location of the three integral airstairs.

Specifications of the IL-86 airliner

Engine type	4 x NK-86
Thrust, kgp (lbst)	4 x 13,000 (28,665)
Wing span	48.6 m (160 ft 0 in)
Length overall	59.94 m (196 ft 8 in)
Height on ground	15.81 m (51 ft 10½ in)
Wing area, m² (sq ft)	320.0 (3,444.79)
Passenger cabin dimensions:	
maximum width	5.70 m (18 ft 8½ in)
height	2.61 m (8 ft 6 in)
Seating capacity:	
in mixed-class configuration	234
in all-economy configuration	350
Maximum TOW, kg (lb) (depending on the runway type and length)	190,000-215,000 (418,950-474,075)
Equipped empty weight, kg (lb)	115,000 (253,575)
Maximum landing weight, kg (lb)	175,000 (358,875)
Maximum payload, kg (lb)	42,000 (92,610)
Maximum fuel load, kg (lb)	86,000 (189,630)
Cruising speed at 9,000-11,000 m (29,530-36,090 ft), km/h (mph)	900-950 (559-590)
Landing approach speed, km/h (mph)	240-260 (149-162)
Required runway length for take-off and landing, m (ft)	2,300-2,600 (7,550-8,530)
Practical range, km (miles)	
with a maximum payload	3,000 (1,865)
with a payload of 40,000 kg (88,200 lb)	3,600 (2,237)
with maximum fuel	4,600 (2,859)

Electrical system: Primary 200/115V/400 Hz three-phase AC is supplied by four engine-driven GT-40PCh6 generators. The primary system is supplemented by two secondary systems, one of them supplying 36V/400 Hz AC and the other 27V DC. On the ground, with the engines shut down, electric power is fed from the APU generator, external power supply or storage batteries.

Avionics and equipment: The Omega long-range navigation system enables the aircraft to stay on course at route stretches not provided with radio beacons, and the Pizhma-1 onboard navigation suite makes it possible to fly at any time of the year and any time round the clock on domestic and international routes in adverse weather conditions without navigator. The onboard navigation suite maintains a pre-set flight programme which can be corrected at short notice and even allows a landing approach to be made according to a pattern current at a given airport.

IL-86D widebody airliner (project)

Drawing upon its experience gained in the course of development, construction and scheduled operation of its first widebody medium-haul airliner– the IL-86 – the team of designers in the Ilyushin OKB set about designing its long-haul version, the IL-86D (***dahl'niy***, long-range).

On 1st June 1972 MAP and MGA adopted a joint decision on the development of a cargo/passenger (combi) version of the IL-86; two years later, on 26th June 1972, the Communist Party Central Committee and the Council of Ministers issued a joint directive on the development of the IL-86D widebody long-haul airliner intended to carry 300 to 350 passengers to a distance of 8,500-9,000 km (5,283-5,594 miles).

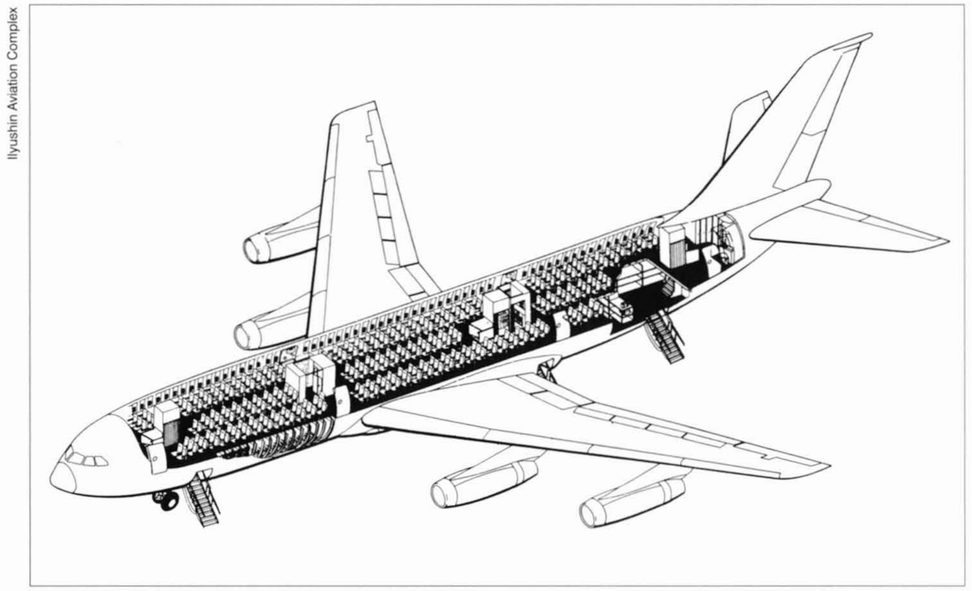
The work on the advanced development project of the IL-86D was completed on 25th February 1976. The aircraft differed from its predecessor, the IL-86, only in having increased wing area and in being powered by four new Lotarev D-18 high by-pass turbofans delivering 20,850 kgp (45,970 lbst) apiece for take off. However, by the end of the 1970s a new approach gained acceptance concerning the problem of fuel efficiency of airliners. Influenced by this new approach, the designers arrived at the conclusion that a new, more advanced design was needed.

IL-96 widebody airliner (first project version)

At the end of the 1970s the Ilyushin OKB developed a new project of a long-haul airbus designated IL-96. This aircraft differed outwardly from its predecessor, the IL-86, in having a T-tail and in being powered by Kuznetsov NK-56 turbofans rated at 18,000 kgp (39,690 lb) in larger-diameter nacelles. This airliner was intended to carry 350 passengers, baggage and cargo with a total weight of up to 40 tonnes (88,200 lb) on domestic trunk routes of 4,000-9,000 km (2,486-5,594 miles) with a high-density traffic. It was also envisaged for use at stage lengths of up to 11,000 km (6,837 miles) with an appropriate reduction in seating capacity. The aircraft was intended to supplant the IL-62 airliner which had been operated on these routes since 1967.

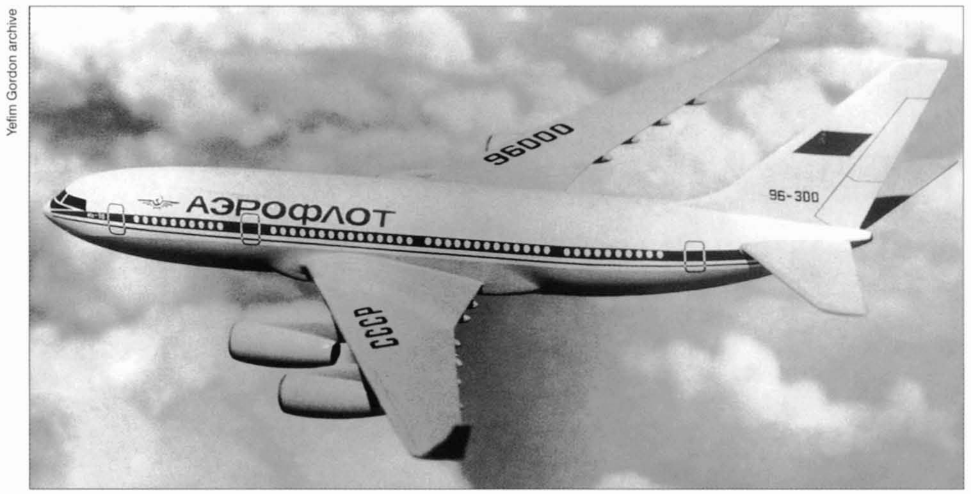
Assisted by TsAGI specialists, designers of the Ilyushin OKB, now called the Ilyushin Aviation Complex, succeeded in designing new wings for the IL-96 taking into account recent advances in aerodynamics. The wings differed from those of the IL-86 in having greater aspect ratio, more moderate sweepback (30°), new airfoil sections and a higher lift/drag ratio.

When the advanced development project was completed, the designers set about preparing manufacturing drawings. Nevertheless, the aircraft did not reach the hardware stage in this configuration because MAP took a radically different decision (see below).



Ilyushin Aviation Complex

A cutaway drawing of the IL-86.



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An artist's impression of the IL-96-300 from the project documents.

IL-96-300 long-haul widebody airliner

In early 1980s the Soviet Ministry of Aircraft Industry came up with the idea of developing new-generation medium-haul and long-haul airliners designed around a single standardised high bypass ratio turbofan type. This was to be the D-90AN turbofan then under development in the OKB headed by General Designer Pavel A. Solov'yov. The Tupolev OKB, now bearing the name Tupolev ANTK (Aviation Scientific & Technical Complex named after Tupolev) was to be tasked with developing the Tu-204 medium-haul airliner (originally conceived as a trijet with two engines under the wings and a third in the rear fuselage), and the Ilyushin Design Bureau was expected to produce the four-engined IL-96. The use of the same engine would increase the production run of the D-90AN, reducing unit costs and increasing the profitability of the new airliners.

The D-90AN turbofan developed for the Tu-204 trijet initially had a design thrust rating of 13,500 kgp (29,767 lbst). This was clearly insufficient for the heavier IL-96; therefore Ilyushin OKB General Designer Ghenrikh V. Novozhilov suggested that the engine be uprated to 16,000 kgp (35,280 lbst). This met no objections from the designers of the Tu-204 who could redesign their machine into the twin-engined aircraft we know today. The idea was also approved by MAP. Thus, the early 1980s saw the beginning of design work not only on a new generation of Soviet airliners but also on a completely new engine for them; this was the PS-90A turbofan (initially known as the D-90A).

Calculations showed, however, that an engine delivering 16,000 kgp would still be

inadequate for a long-haul airliner carrying 350 passengers. Therefore, Novozhilov suggested that the IL-96's seating capacity be reduced to 300; MAP's top leaders had no choice but to give their consent. As a result, the fuselage of the new version of the IL-96 'airbus' had the same diameter as that of the IL-86 (6.08 m/19 ft 11⅜ in) but was 5 m (16 ft 4⅞ in) shorter – just long enough to accommodate 300 seats. In their work on the aircraft's design Ilyushin engineers made use of the most up-to-date techniques of calculations and state-of-the-art production methods, which made it possible to enhance the machine's performance, reliability and flight safety. The overall airframe weight was brought down and steps were taken to improve the quality of external finishing.

Special research and experiments conducted by the Ilyushin OKB staff together with TsAGI specialists enabled the OKB to design for the IL-96 swept wings with supercritical airfoils and winglets increasing the wings' lift/drag ratio. In addition, steps were taken to improve the 'local' aerodynamics of the wings. Among other things, the use of large skin panels helped minimise the number of panel joints; the designers succeeded in selecting the optimum configuration of joints between the wing and the fuselage and between the wings and the engine nacelle pylons. The wings were provided with efficient high-lift devices: full-span LE slats, inboard double-slotted flaps and outboard single-slotted flaps. The wings were also fitted with devices for lateral control – inboard high-speed ailerons and spoilers.

In the course of airframe design a thorough analysis was undertaken of all stresses to which the airliner is subjected; deformations of the airframe under stresses were simulated with the help of computers and optimum configurations of the structure were selected. This made it possible to reduce the aircraft's weight and to ensure its long service life.

Ilyushin Aviation Complex

Above: The first prototype IL-96-300, CCCP-96000 (c/n 0101), takes shape at the Ilyushin OKB's experimental plant. Note the deflected high-speed aileron between the inner and outer flap sections.

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CCCP-96000 captured by the camera during trials. Note the Le Bourget '89 exhibit code 386.

Special features of the powerplant comprising four PS-90A turbofans were its low specific fuel consumption in cruise flight, a low noise level and a two-channel full authority digital engine control (FADEC) system. A new flight instrumentation/navigation suite featuring an electronic flight instrumentation system (EFIS) with six cathode-ray tube (CRT) displays ensured virtually completely automated navigation in instrument meteorological conditions over any area of the world and enabled a crew of only three persons (captain, first officer and flight engineer) to perform ICAO Cat IIIA blind landings. The introduction of such avionics reduced the crew workload, enhanced flight safety and helped strictly maintain flight schedules.

The use of state-of-the-art functional systems made it possible not only to reduce considerably the aircraft's weight and increase the level of flight automation but also ensured efficient and safe operation of the aircraft. This goal was attained through the use of the following systems incorporated into the design of the aircraft: a fly-by-wire (FBW) control system, an automated system controlling the high-lift devices during take-off and landing, and an integrated system for the presentation of flight data and systems status information through colour images on CRT displays in the flightdeck.

The flightdeck was configured according to the forward-facing crew cockpit (FFCC) principle, the flight engineer facing the central control pedestal between the pilots throughout the flight. This arrangement became possible thanks to the use of the latest means of automation and electronics.

The information displays and devices for onboard systems control were placed in the relatively small forward area of the flightdeck which was common for all the crew; the displays were accommodated on the instrument panel, the central control pedestal and the overhead circuit breaker panel. All information about the functioning of onboard systems and about the navigation and piloting situation was to be presented in a thoroughly processed form to preclude any possibility of its being misinterpreted. Additionally, to facilitate quick and timely perception of the information, the 'dark cockpit' principle was implemented; in accordance with this principle no information signals should be visible on displays during the whole course of the flight when onboard systems are functioning normally and there are no malfunctions (an exception being the information about the activation of temporarily functioning systems).

Ilyushin Aviation Complex

A fabulous air-to-air of the first prototype. The IL-96-300 is a well-proportioned aircraft. Note the outer spoilers on the port wing deployed differentially for roll control.

The latest means of flight data presentation made it possible to ensure a quick change in the type of information, as determined by flight modes, keeping its volume down to the minimum required by each of these flight modes. The use of colour coding enhanced the ability of the warning systems to convey information, making its presentation more graphic and clear. The number of indicators was reduced by a factor of three.

The IL-96 was also projected as a double-deck aircraft. Like the IL-86, it was to be operated in two versions – a 300-seat tourist-class configuration and a mixed-class version. The former arrangement was regarded as the baseline version. Its passenger cabins featured nine-abreast twin-aisle seating. The cabins were provided with an in-flight entertainment (IFE) system. The seats had reclining backs, built-in individual ventilation nozzles (a feature also used on the IL-86) and reading lights. Following the established standard for this class of aircraft, the catering equipment comprised a meal tray in the back of the seat ahead and earphone sockets for listening to music or movie soundtracks without disturbing your fellow passengers. Two meals were to be served in long-duration flights. To cater for this, a galley was set up on the lower deck.

Both passenger cabins had permanent coat closets intended for the summer period. During the cold seasons additional coat closets were to be set up at the expense of removing some seats. In the mixed-class version, the main deck was to be divided into three compartments accommodating 22, 40 and 173 seats respectively. The first two compartments were separated by an additional galley.

Two large compartments on the lower deck were intended for cargo in standard LD-3 containers. With all the passenger seats on the upper deck occupied, nine containers were to accommodate the passengers' baggage, and seven were intended for mail and urgent cargoes. The third compartment on the lower deck was intended primarily for bulk cargo.

On 1st December 1986 a full-scale mock-up of the IL-96-300 long-haul passenger aircraft was submitted to the customer (the Ministry of Civil Aviation) for inspection. In the course of its work the mock-up review commission endorsed the main performance specifications and basic design features of the prospective aircraft; these included a maximum payload of 40 tonnes (88,200 lb), an all-up weight of 216 tonnes (476,280 lb), a maximum seating capacity of 300, a practical range of 11,000 km (6,837 miles) with a payload of 65 tonnes (143,325 lb), a cruise altitude of 10,100-12,100 m (33,140-39,700 ft) and a cruising speed of 850-900 km/h (528-559 mph).

On 28th September 1988 the prototype of the IL-96-300 widebody airliner registered CCCP-96000 (c/n 0101, that is, batch 01, first aircraft in the batch) made its maiden flight from the Central Airfield (Moscow-Khodynka). The crew was captained by Ilyushin OKB chief test pilot Stanislav G. Bliznyuk, Hero of the Soviet Union, Merited Test Pilot of the USSR. It also included project engineer V. S. Kroogly akov. This flight marked the beginning of the aircraft's flight-test stage. On 20th August 1989 the prototype – again flown by S. G. Bliznyuk – took part in the annual Aviation Day air display at Moscow-Tushino.

While the IL-96 was still on the drawing boards, a decision was taken to launch series production at the Voronezh Aircraft Production Association (VAPO – *Vo**ron**ezhskoye aviatsi**on**noye proiz**vod**stvennoye obyedi**nen**iye*); in post-Soviet days this enterprise was renamed Voronezh Joint Stock Aircraft Production Co. (VASO – *Vo**ron**ezhskoye aktsio**ner**noye samo**lyo**tostroitel'noye **ob**shchestvo*). On 11th Novem-

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In post-Soviet days the third prototype IL-96-300, RA-96002 (c/n 01-03), was converted for cargo carriage by Atlant-Soyuz, operating from Zhukovskiy.

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IL-96-300 RA-96002 'cleans up' as it departs Zhukovskiy.

ber 1989 the second IL-96-300 prototype, CCCP-96001 (c/n 0103), made its first flight from VAPO's factory airfield (Voronezh-Pridacha). The crew was captained by S. G. Bliznyuk, with factory test pilot A. S. Kokalin as first officer. Four months later, on 14th February 1990, this machine took part in the 5th Asian Aerospace airshow in Singapore (with S. G. Bliznyuk at the controls). On 21st April the aircraft performed a long-range flight on the Moscow – Yuzhno-Sakhalinsk – Khabarovsk – Moscow route with a refuelling stop at Khabarovsk-Novyy airport. Again, the crew was captained by Stanislav G. Bliznyuk, and Ilyushin OKB General Designer Ghenrikh V. Novozhilov personally accepted the overall responsibility for the flight.

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The flightdeck of an IL-96-300 prototype, showing the six large CRT displays. The instruments on top of the instrument panel shroud are part of the test instrumentation.

On 9th July 1990 the first production IL-96-300, CCCP-96002 (c/n 74393201001), made its first flight from Voronezh-Pridacha. (Again, 743 must be a product code, 9 means the ninth post-war type built in Voronezh and 32 is the factory code, followed by the Voronezh production batch number (?) and the sequential line number.) Thus, the Voronezh Aircraft Production Company succeeded in mastering the series production of the IL-96-300 within a tight schedule and was in a position to offer the customers speedy deliveries.

On 21st/22nd November 1991 the second production machine (CCCP-96005, c/n 74393201002) performed a flight intended to check its range and maximum endurance; it followed the Moscow – Petropavlovsk-Kamchatskiy – Moscow route. A distance of 14,800 km (9,192 miles) was covered within 18 hours 9 minutes. The flight was performed by a crew captained by Anatoliy N. Knyshov, a test pilot of what was already the Ilyushin Aviation Complex. Route proving flights were started on 3rd February 1992. On 9th June that year the third production IL-96-300 (CCCP-96006, c/n 74393201003) set off along the Moscow-North Pole-Anchorage-Portland route for the purpose of participating in the festivities marking the 55th anniversary of Valeriy P. Chkalov's epic record-breaking flight in the Tupolev ANT-25 over the North Pole to the USA. The crew was captained by A. N. Knyshov, and V. S. Krooglyakov headed the expedition. From 21st to 25th October IL-96-300 RA-96005 took part in Airshow Down Under in Avalon (Australia).

In the meantime, flight testing of the prototypes continued in accordance with various programmes. For example, between 8th and 22nd February 1991 the IL-96-300 was tested in extremely low ambient temperatures (down to –53° C) with the assistance of the Yakutsk Air Enterprise; the jet was captained by O. S. Sergiyenko, with V. B. Lysyagin as project engineer. On 29th December 1992 the Russian airworthiness authorities – the Air Register of the Interstate Aviation Committee (MAK, a joint CIS authority) – awarded the Ilyushin Aviation Complex a type certificate testifying that the IL-96-300 met the NLGS-3 airworthiness requirements. In the course of certification testing the IL-96-300 made 1,769 flights, logging 3,100 hours in all. The MAK Air Register awarded the Ilyushin company Certificate No.R-1 acknowledging the enterprise was eligible for undertaking civil aircraft design work. On 12th April 1993 on the grounds of the type certificate issued by the MAK Air Register, MAK issued an order clearing the PS-90A-powered IL-96-300 aircraft to perform flights on domestic and international air routes for the purpose of carrying baggage, mail and cargoes. On 20th May of that year the MAK Air Register issued a supplementary type certificate increasing the maximum permissible number of persons on board to 315, and on 28th June a certificate regarding the ambient noise level was issued. Two weeks later, on 12th July 1993, the MAK Air Register issued another supplementary type certificate regarding a major alteration of the aircraft's design – an increase of the take-off weight from 230 to 240 tonnes (507,150 to 529,200 lb).

Thus, from 13th July 1993, pursuant to order No.DV-94 issued by the Air Transport department of the Russian Ministry of Transport, ten IL-96-300 airliners were granted the right to perform passenger flights on domestic and international air routes, effective as of 14th July. On the same day, the PS-90A-powered IL-96-300 performed its first revenue service from Moscow/Sheremet'yevo-2 to New York's J. F. Kennedy International; on 31st July Aeroflot's new flagship started scheduled passenger services to Madrid and Barcelona. On 13th November the IL-96-300s started flying from Moscow to Las Palmas, services to London-Heathrow commencing the following day.

The year 1994 saw the beginning of scheduled revenue services to Seoul, San Francisco, Seattle and Los Angeles. On 17th June of that year, upon completion of a lengthy series of tests, the Voronezh Aircraft Production JSC (VASO) delivered an IL-96-300 (RA-96005) to the operational subdivision of the Aeroflot Russian International Airlines. (Interestingly, this aircraft which had taken to the air for the first time as early as 1991, was officially released by the factory only on 17th April (according to other documents, 17th June 1994!). A new subdivision, the 217th Flight, was specially formed by ARIA for operating the IL-96, supplementing the existing 63rd, 64th, 207th and 216th Flights inherited from the former TsUMVS (Central Directorate of International Services). On 31st October scheduled services were started on the Moscow-Buenos Aires-Moscow route with intermediate stops at Amilcar Cabral International airport on the Island of Sal (the Azores). On 4th November ARIA introduced the IL-96-300 on the Moscow-Larnaca-Sal-Rio de Janeiro-São Paulo-Sal-Larnaca-Moscow route. Finally, on 25th May 1995 scheduled passenger services with this type of airliner were started on the Moscow-Paris route. Later the IL-96-300 was also issued to the 206th Flight of the Domodedovo Civil Aviation Production Association which had previously flown the IL-62M (at present this enterprise is called Domodedovo Airlines).

From the outset the IL-96 was envisioned as a baseline aircraft for a whole family of widebody aircraft intended for various uses and possessing a commonality of the airframe and systems but differing in payload, range, type and number of engines. For this purpose in the second half of the 1980s the Ilyushin Aviation Complex evolved a 'Pro-

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Aeroflot Russian Airlines IL-96-300 RA-96005 (c/n 74393201002) at London-Heathrow in 1973-standard colours. In February 2004 it became the first IL-96-300 to gain Aeroflot's all-new livery.

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Above: The Domodedovo Civil Aviation Production Association was the second operator of the type. This is RA-96006 (c/n 74393201003), the first of three in the fleet, at Moscow-Domodedovo on 3rd November 1998.

Dmitriy Petrochenko

RA-96007 (c/n 74393201004) awaits the next load of passengers at Sheremet'yevo-2.

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The first prototype IL-96-300 is seen here at MMZ No.240 in the process of conversion to the IL-96M prototype. It is easy to see how the fuselage has been cut up at the production breaks and new fuselage sections inserted. The engine pylons have been removed, as the PW2337 turbofans require a different pylon design.

gramme for developing Ilyushin passenger and transport aircraft up to the year 2000'. Practical implementation of the programme was facilitated by the high level of technical perfection of the baseline variant with respect to aerodynamics, airframe design, onboard systems and equipment.

IL-96MO (IL-96M) widebody airliner

Test flights performed on the IL-96-300 with its extreme forward position of the CG by test pilots Stanislav G. Bliznyuk and Anatoliy N. Knyshov demonstrated that the aircraft possessed normal stability and controllability characteristics and adequate effectiveness of control surfaces in all flight modes. This made it possible to considerably lengthen the forward fuselage when projecting various versions. Static and fatigue tests of the IL-96-300 confirmed the feasibility of creating a 'stretched' version of the aircraft. The airframe, systems and equipment of the IL-96-300 had also been projected bearing in mind the possibility of fitting prospective versions of this aircraft with still more up-to-date avionics and equipment of both Russian and foreign manufacture. In accordance with the abovementioned 'Programme for developing Ilyushin passenger and transport aircraft up to the year 2000' Ilyushin designers developed projects of the IL-96M (*modifitseerovannyy* – modified) passenger aircraft and the IL-96T cargo aircraft described later. These machines differed from the baseline IL-96-300 in having a higher payload (the IL-96M could carry a maximum of 436 passengers) and greater non-stop range. To achieve this, the fuselage was stretched by 9.35 m (30 ft 8⅛ in) by inserting two cylindrical plugs ahead and aft of the wings, measuring 6.05 m (19 ft 10⅛ in) and 3.3 m (10 ft 10 in) respectively. This resulted in the all-up weight of the stretched aircraft reaching 270 tonnes (595,350 lb).

Foreign aerospace companies showed an interest in the versions under development, and the programme turned international. On 4th December 1989 negotiations were started between the business communities of the USA and Israel and the Soviet Ministry of Aircraft Industry on developing versions of the IL-96-300 and Tu-204 with Western engines and avionics. Alongside a great number of suppliers of equipment items from Russia and other CIS countries (after the demise of the USSR, that is), 18 American aeronautical companies took part in the development of the IL-96M/T versions. The programme was endorsed by the Presidents of Russia and the USA. On 7th December 1990 a Protocol was signed providing for the preparation of a feasibility study concerning the fitting of the IL-96M with Pratt & Whitney PW2337 turbofans (a version of the PW2037 adapted to the Ilyushin aircraft) rated at 17,000 kgp (37,485 lbst). The Protocol envisaged completion of the first aircraft before the opening of the 1993 Paris Airshow. However, the question of funding the programme remained unresolved for a long time, and the work on the construction of the IL-96M prototype intended for initial certification tests with the Pratt & Whitney engines and Rockwell Collins avionics was financed by the participants of the programme. For the first time in its history the Ilyushin Aviation Complex faced numerous new questions related to the organisation of joint work of specialists from different countries, to certification of the aircraft in accordance with standards that would ensure its competitiveness on the world market, to marketing and funding. Specialists from Russia and the USA were mutually acquainted with the special design features of the IL-96M/T and their systems, the PW2337 engines and the Rockwell Collins flight instrumentation/navigation suite. Concurrently lists were drawn up of equipment items scheduled for delivery, technical questions were solved concerning their location on the aircraft and mutual co-ordination of the American engine information and crew alerting system (EICAS) and other avionics with the Russian systems and equipment of the IL-96M/T. Jointly with Russia's State Air Register and the US Federal Aviation Administration (FAA) a certification basis for the IL-96M/T was evolved; it took into account the stipulations of the Russian national airworthiness standards (Aviation Regulations) and the US Federal Aviation Regulations (FAR 23).

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The IL-96MO pictured during the rollout ceremony at Moscow-Khodynka on 29th March 1993. The old combat jets in the background are the exhibits of an open-air museum (unfortunately closed now).

On 30th November 1991 a crew captained by test pilot Stanislav G. Bliznyuk landed the first prototype IL-96-300 (CCCP-96000) at Moscow-Khodynka where it was to be subjected to a major conversion at MMZ No.240, becoming the first prototype IL-96M. Called IL-96MO (***o**pytnyy* – experimental) and properly reregistered RA-96000, the converted aircraft was rolled out on 29th March 1993 and took to the air for the first time from Khodynka on 4th (some sources say 6th) April with test pilots S. G. Bliznyuk and A. N. Knyshov at the controls.

In June the aircraft was unveiled at the Paris Airshow, drawing favourable comment from Western experts. Assessing the IL-96MO, Rockwell Collins test pilot Ross Wains said, 'It is a real pleasure to fly this aircraft. It has good stability and controllability in banking turns up to 40° and is on a par with Western counterparts.'

Between 31st August and 5th September of that year the IL-96MO took part in the MAKS-93 airshow, and on 3rd November 1994 the MAK Air Register issued a special Certificate of Airworthiness for the IL-96MO powered by PW2337 engines. A few days later, between 6th and 17th November, the airliner performed several demonstration flights at Andrews AFB (Maryland, USA) so as to show the joint work of Russian and US companies. The aircraft was flown by a crew captained by Stanislav G. Bliznyuk.

Airline specialists had an opportunity to familiarise themselves with the new Russian airliner, and orders for the IL-96M/T started coming in. Aeroflot Russian International Airlines (ARIA) was the launch customer, ordering 20 IL-96T cargo aircraft and IL-96M airliners. This was accompanied by the emergence of a spate of new problems; the need for solving them as a prerequisite for successful commercial activities on the home and international markets became especially pronounced under the conditions of economic reforms that had been launched in Russia.

Between 21st and 26th March 1995 the IL-96MO was demonstrated at Airshow Down Under '95 in Melbourne, Australia. The crews were captained by Anatoliy N. Knyshov and Igor' R. Zakirov. The delegation was headed by V. V. Livanov, General Director of the production facility of the Ilyushin Aviation Complex. From 11th to 15th June 1995 the IL-96MO took part in the 41st International Aerospace Show in Paris (the crews were captained by S. G. Bliznyuk and I. I. Goodkov). It was there that an agreement was signed between ARIA and the Ilyushin Aviation Complex on the delivery schedule for 20 IL-96M/T aircraft (ten passenger IL-96Ms in the 318-seat configuration and ten IL-96T cargo aircraft) powered by Pratt & Whitney engines and fitted with Rockwell Collins avionics. In August and November of that year the IL-96MO was demonstrated at the MAKS-95 airshow in Zhukovskiy and at the International Trade Fair in New Delhi respectively. In February 1996 it took part in the Asian Aerospace '96 show in Singapore.

On 3rd December 1996 an agreement was signed between Aeroflot, Ilyushin Aviation Complex and VASO on the acquisition by Aeroflot of 20 IL-96M/T aircraft powered by Pratt & Whitney engines and fitted with Rockwell Collins avionics. Bearing in mind the importance of the programme designed to support aircraft construction in Russia, on 4th February 1997 the Government of the Russian Federation adopted a Directive 'On measures of State support for the manufacture of IL-96M/T aircraft'. Later (in 1998) Aeroflot changed its order: instead of ten IL-96M airliners and ten IL-96T cargo aircraft the order envisaged the delivery of 17 IL-96Ms and three IL-96Ts.

In early December of that year demonstration flights of the IL-96MO were conducted in North Korea (crew captain Igor' R. Zakirov), but for several reasons, including political ones, the signing of a deal on the export deliveries to that country fell through.

In early 2001 the IL-96MO prototype underwent modification (see below).

IL-96T cargo aircraft

As mentioned earlier, concurrently with the project of the IL-96M passenger aircraft a project of its cargo version, the IL-96T (sometimes designated IL-96MT) was developed; it could carry 92 tonnes (22,860 lb) of cargo to a distance of 5,200 km (3,232 miles) or 40 tonnes (88,200 lb) to a distance of 12,500 km (7,769 miles). The cargo version had a series of special design features. The main cargo deck could accommodate up to

Dmitriy Komissarov

The IL-96T prototype, RA-96101, is unveiled to the Russian public at the MAKS-97 airshow. Note the Le Bourget '97 exhibit code 337 and the almost windowless fuselage.

Yefim Gordon

The IL-96T makes an impressive picture as it comes in to land at Zhukovskiy after a demonstration flight. This view shows well the aft position of the centreline main gear unit.

25 cargo pallets measuring 3.175 m (10 ft 5 in) in length and having a standard cross-section of 2.44 x 2.44 m (8 x 8 ft). The loading was effected through an upward-opening cargo door measuring 4.85 x 2.875 m (15 ft 11 in x 9 ft 5 in) located on the port side of the forward fuselage. It was possible to accommodate cargo pallets measuring 6.8 m (22 ft 3¾ in) in length. The two lower-deck cargo holds housed 32 standard LD-3 containers or pallets. All cargo handling operations were mechanised; there was a ball mat and roller conveyors on the main deck, as well as quick-release locks for tying down the cargo pallets. Almost all cabin windows and passenger doors (except the forward pair of doors) were deleted. In the cargo hold, immediately behind the rear partition of the flightdeck, there was a compartment for cargo attendants with the necessary life support amenities and emergency rescue equipment. This compartment was separated from the cargo hold by a flexible smoke curtain and by an emergency net stressed to withstand 9-G loads which could be created (although this was rather improbable) by cargoes bursting their tie-down gear during an emergency landing.

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Close-up of the IL-96T's open cargo door; the four actuators are clearly visible.

As was the case with the baseline IL-96M, the IL-96T was powered by fuel-efficient and 'environmentally friendly' Pratt & Whitney PW2337 engines and fitted with Rockwell Collins avionics. The new electronics determined the basic principles of the flightdeck layout, the design of which marked the final stage of the evolution of flightdecks of Ilyushin aircraft from a five-man crew on the IL-62 to three on the IL-86 and IL-96-300 and, finally, two crew on the IL-96T. The elimination of the radio operator, and then the navigator and flight engineer, their duties being taken over by the remaining two crew, became possible thanks to the introduction of state-of-the-art electronics and computer technology. A high level of flight management automation, presentation of all flight information and navigation data, as well as information on the functioning of onboard systems, on the multi-function colour displays of the 'glass cockpit' enabled a crew of two (captain and first officer) to control the flight efficiently and securely. Nevertheless, placed behind the seats of captain and first officer were extra seats for two observers (inspectors or escort navigators).

When determining the layout and arrangement of the flightdeck, its designers sought to provide a maximum degree of flight safety and ensure trouble-free regular operation of the aircraft. Provision was made for extra seats and rest facilities for a relief crew; this enabled air operators to select the optimum mode of pilots' work on long routes. The Pratt & Whitney engines and Rockwell Collins avionics featured state-of-the-art electronic components, possessed international certificates and could rely on a world-wide support and maintenance network, encompassing virtually all countries of the world. Bearing in mind the IL-96T's enormous range, this was expected to ensure for the air carriers operating the aircraft a guaranteed revenue from cargo-carrying operations, especially transcontinental ones, the volume of which, as evidenced by marketing research, had a tendency to a stable growth. The combination of high performance characteristics with a high load-carrying capacity, in terms of this class of aircraft, coupled with the use of US engines and avionics made the IL-96T competitive on the world market over the then-latest Western widebody long-range transport aircraft – the McDonnell Douglas MD-11F (the IL-96T had a 2-tonne/4,410-lb greater maximum payload) and the cargo version of the Airbus Industrie A340-300 which was then under development. Thanks to its greater speed and range the IL-96T possessed economic advantages over the IL-76 as well. However, the two were not rivals – actually, they complemented each other; the IL-96T was expected to become a transcontinental cargo 'express liner', whilst the IL-76 remained a workhorse and 'maid of all work'.

The creation of the IL-96T became possible thanks to the wealth of scientific and technical experience amassed in the course of design and construction work on the first widebody passenger aircraft – the IL-86 and the IL-96-300.

On 26th April 1997 a festive ceremony was held by the Voronezh Aircraft Production Company; it marked the completion of the IL-96T cargo aircraft prototype registered RA-96101 (c/n 0001 96T?) which was submitted for flight testing. Among the participants at the ceremony was Viktor S. Chernomyrdin – the then Prime Minister of Russia. On 16th May the aircraft made its first flight, manned by a crew comprising Ilyushin Aviation Complex chief test pilot Stanislav G. Bliznyuk, co-pilot Anatoliy N. Knyshov and flight engineer M. N. Yunisov. Between 15th and 22nd June the IL-96T took part in the 42nd Paris Airshow at Le Bourget, and from 19th to 24th August it was displayed statically and in flight at the MAKS-97 airshow in Zhukovskiy.

On 3rd November 1997 the CIS Interstate Aviation Committee (MAK) issued a certificate for community noise which testified that the type design of the IL-96T powered by the PW2337 engines was ICAO Chapter 16/Stage III compliant. Two days later, on 5th November, MAK issued a provisional type certificate for the IL-96T.

However, further prospects for this version (as well as those of its passenger stablemate, the IL-96M) have been put in jeopardy. Aeroflot Russian Airlines (formerly ARIA), which had previously placed an order for three IL-96Ts, later cancelled it. Apparently the same fate befell an order for four IL-96Ts made in 1997 by the cargo carrier Volga-Dnepr Airlines. This was partly due to the fact that the manufacturer had failed to procure a sufficient number of PW2337 engines (the US partners had stated so many preconditions, including a requirement that Aeroflot order a certain number of American airliners, that the whole thing became pointless). In 2003 the IL-96T prototype (RA-96101) was ferried from Zhukovskiy to Voronezh where work got under way on converting it to the IL-96-400T standard (see below) for a new customer – the Atlant-Soyuz air carrier.

IL-98 (IL-96MD) widebody airliner (project)

Designated initially IL-96MD and later renamed IL-98 was a projected version of the IL-96M powered by two 37,195-kgp (82,000-lbst) Pratt & Whitney PW4382s or two NK-44 engines developed by the Kuznetsov OKB (now known as Samara Scientific & Technical Complex named after Nikolay D. Kuznetsov); the latter engines were to have a take-off thrust of 40,000 kgp (88,200 lbst) each. According to calculations, the new twin-engined airbus was expected to be considerably superior to the IL-96M as regards range and economic characteristics. Had the production PW4382 engines been selected, the IL-98 programme could have been implemented within a mere 3½ to 4 years. However, the economic situation of Russia's aerospace industry prevented this Russian counterpart of the Boeing 777 from materialising.

IL-96M-500 widebody airliner (project)

The early 1990s saw a clear world-wide tendency towards a growth of passenger air traffic; as a consequence, all major aircraft-manufacturing countries, including Russia, initiated feasibility studies designed to demonstrate the need for passenger aircraft with a high or ultra-high seating capacity. The Ilyushin Aviation Complex was conducting initial studies of two IL-96M derivatives intended to carry 500 and 750 passengers and tentatively designated IL-96M-500 and IL-96M-750 respectively. The new versions were envisaged as double-deck aircraft; the former was to have a powerplant comprising four new NK-93 engines under development in the Kuznetsov OKB; these were low-noise, fuel-efficient ultra-high bypass (UHB) engines (initial plans had called for the installation of NK-92 ducted-fan engines delivering a thrust of 18,000-20,000 kgp/ 39,690-44,100 lbst for take off and with a by-pass ratio of 17 to 18). Such airbuses were needed by big air carriers. However, not one of the world's major aircraft companies was capable of developing such an aircraft on its own, without broad international co-operation. The Ilyushin Aviation Complex specialists were among those who gave serious consideration to the possibilities of international co-operation with a view to developing IL-96M derivatives. However, yet again the economic crisis, the lack of tangible interest on the part of prospective customers and, in consequence, lack of funding led to a decision to suspend the work on these projects.

IL-196 (IL-96M-750) widebody airliner (project)

The IL-96M-750 aircraft which was renamed IL-196 in the course of projecting differed from the above-mentioned IL-96M-500 airbus in having greater seating capacity (680 to 600 passengers in the three-class and all-economy configurations respectively), bigger dimensions and take-off weight and, accordingly, a different powerplant which was to comprise four NK-44 turbofans rated at 40,000 kg (88,200 lb) for take-off. The project of this version remained on the drawing board for the reasons cited above.

Dmitriy Komissarov

A model of a projected IL-96M version powered by NK-93 CRISP engines on display at the MAKS-99 airshow.

IL-96-300PU and IL-96-300PU(M) presidential VVIP aircraft

In early 1990s Russia's President Boris N. Yeltsin had a specially equipped IL-62M 'Salon TM-3SUR' VIP aircraft belonging to the 'Russia' State Air Transport Company at his disposal for official use. By then this aircraft was already obsolescent. Hence on 21st July 1992 the President of the Russian Federation issued a decree providing for the development of the IL-96PU VIP aircraft based on the IL-96-300 widebody long-range airliner. PU stood for *poonkt oopravleniya* (command post); it was not a reference to Vladimir V. Putin, as some people claim, since development of the IL-96PU had been completed *before* Putin became President. (It should be noted, though, that the 235th Independent Flight Detachment later transformed into the 'Russia' State Transport Company had been sizing up the IL-96-300 prior to that. On 24th June 1992 CCCP-96005 could be seen at Moscow/ Sheremet'yevo-1 airport sporting the Russian flag on the fin (despite the Soviet prefix!) and Cyrillic 'Rossiya' (Russia) titles in gold on the fuselage.)

Like the basic airliner, the presidential VVIP version of the aircraft (now designated IL-96-300PU 'Salon') was powered by Russian PS-90A engines, albeit they were specially made examples manufactured with extra attention to quality – it just didn't seem right for the aircraft carrying the President of a major aircraft-manufacturing nation to be powered by imported engines. On the other hand, the plush interior matching the aircraft's status was designed and installed by Jet Aviation AG, a Swiss business aviation operator and outfitter. The VIP cabin comprised a small office for work with a floor area of 10 to 12 m^2 (107.65 to 129.18 sq ft) complete with the communications suite and the so-called 'nuclear suitcase' (a portable control unit enabling the President to authorise a nuclear strike if necessary, wherever he is), and a conference room for 8 to 10 persons (slightly in excess of 20 m^2/215.3 sq ft). A third of the aircraft's useful load was accounted for by secure communications equipment of Russian manufacture installed in the aft fuselage. The latter also accommodated equipment operators maintaining round-the-clock readiness so as to ensure reliable communication with all the world (first and foremost with Russia) with the help of a satellite relay system. This made it possible to use the airliner, in particular under emergencies, as an airborne command post for the Head of State and Supreme Commander-in-Chief of the Armed Forces, hence the PU suffix to the designation.

Outwardly the IL-96-300PU 'Salon' differed from the baseline version intended for ordinary people in having a thick dorsal fairing running from the wing leading edge to the base of the fin (similar to that of the IL-62M 'Salon TM-3SUR') which housed satellite communications and navigation antennas, and three small blade aerials placed in tandem ahead of the said fairing. After the communications equipment had been installed, the aircraft, initially painted white with a blue/red cheatline, red 'Rossiya' titles in stylised Old Russian script and the Russian coat-of-arms with golden trim on the fin (hence the unofficial name *gherbovaya raskrahska* ('coat-of-arms livery') given to this colour scheme) was repainted by the aircraft maintenance unit of KLM Royal Dutch Airlines. The new colour scheme was light grey overall with a white/blue/red cheat line symbolising the Russian flag curving downwards on the fuselage nose; the aircraft wore red 'Rossiya' titles in ordinary script and, in keeping with its role, the Presidential flag on the tail in lieu of the Russian coat-of-arms. Alas, the new colour scheme adopted as standard by the 'Russia' State Transport Company looks much less pleasing to the eye and has already earned the nickname *seryy oozhas* ('abominable grey').

From 22nd to 27th August 1995 the IL-96-300PU (RA-96012, c/n 74393201009) was shown at the MAKS-95 airshow in Zhukovskiy (still wearing the 'coat-of-arms' livery and lacking the special communications equipment). On 12th October 1996 the aircraft made its first flight with a fully equipped interior from the factory airfield of Jet Aviation AG in Basel (Switzerland) where the aircraft had undergone its refit. It was captained by A. Kokalin, a test pilot of the Voronezh Aircraft Production Company. In early 1997 the presidential IL-62M 'Salon TM-3SUR' was finally superseded by the more advanced IL-96-300PU 'Salon'. On 20th March 1997 RA-96012 made its first operational flight with President Yeltsin to Helsinki where the Russian President had a meeting with US President Bill Clinton.

However, to ensure reliable flights of the head of state on 'top level missions' it was necessary to have another IL-96-300PU 'Salon' as a back-up, in case RA-96012 went unserviceable. Therefore, right on the heels of the first aircraft the Voronezh enterprise started the construction of the second example (c/n 74393202010). Initially it was registered RA-96013, but then someone decided that the President would be ill-served with this 'unlucky' number containing the 'baker's dozen'. Therefore the second IL-96-300PU 'Salon' was reregistered RA-96016, and the 'unlucky' number was transferred to a standard machine with the c/n 74393202013 delivered to Domodedovo Airlines. (So far, nothing untoward has happened to this aircraft – fingers crossed. The machine's c/n also features '13', maybe 'two wrongs make a right'?)

Construction of the second IL-96-300PU became a protracted affair that lasted for several years. One of the reasons was that, when the aircraft was almost complete (and painted in the 'coat-of-arms' livery of Rossiya State Transport Co.), it was decided to incorporate built-in airstairs of the kind fitted to the IL-86, which the first IL-96-300PU lacked; this was duly done by cutting out sections of skin on the port side ahead and aft of the wings and integrating stock IL-86 airstair subassemblies with large reinforcing plates around them. This may explain the fact that RA-96016 has a slightly different designation, IL-96-300PU(M). Another peculiarity was that, unlike RA-96012, the second aircraft had HF comms gear and the associated fat spine from the start.

The first flight did not take place until 21st April 2003; on 2nd May the aircraft was delivered to the customer, the 'Russia' State Transport Company, and ferried to Moscow-Vnukovo airport.

IL-96-400M widebody airliner and IL-96-400T widebody cargo aircraft

A further development of the IL-96M/IL-96T was planned in the shape of IL-96-400M and IL-96-400T respectively, powered by the PS-90A engines of Russian manufacture and fitted with Russian avionics. The work on this programme was initiated to meet the intention of the Moscow-based Atlant-Soyuz airlines to acquire ten IL-96-400T aircraft. (In the meantime, while the work on this programme is in progress, the company has leased from the Ilyushin Aviation Complex the first production IL-96-300 (RA-96002) re-equipped for the carriage of small-size packaged cargoes.

In 2001 the Pratt & Whitney PW2337 engines fitted to the IL-96MO were replaced with PS-90As. At the same time the interior of the passenger cabin was changed. In this configuration the aircraft was demonstrated at the MAKS-2001 airshow in August of that year. According to some reports, preparations were under way for flight testing of the cargo version – the IL-96-400T.

Structural description of the IL-96-300, IL-96M and IL-96T

Type: Long-haul widebody airliner (IL-96-300 and IL-96M) or cargo aircraft (IL-96T) intended for carrying passengers or cargoes on routes 4,000-9,000 km (2,486-5,594 miles) long.

Fuselage: All-metal monocoque structure of circular cross-section measuring 6.08 m (19 ft 11⅜ in) in diameter; it accommodates the flightdeck for three (IL-96-300) or two (IL-96M/T) crew and two passenger cabins with two-aisle seating (2+2+2, 2+4+2 or 3+3+3). In the tourist-class configuration the IL-96-300 has 300 seats mounted at 870 mm (34¼ in) pitch (66 passengers in the forward cabin and 234 in the rear cabin); in the mixed first-class/tourist-class configuration there are 260 seats arranged with a pitch of 1,020 and 870 mm (40⅛ and 34¼ in) respectively. There are three Type Ia main deck doors/emergency exits on each side. The lower deck accommodates two baggage compartments for six and ten LD-3 containers respectively, a bulk cargo compartment aft and a galley, all with doors to starboard.

The IL-96M differs in having the fuselage length increased by 9.35 m (30 ft 8⅛ in) and four main deck doors.

The fuselage of the IL-96T cargo aircraft differs from that of the IL-96M airliner in lacking the Nos, 2, 3 and 4 pairs of main deck doors, galley service door and most of the cabin windows, as well as passenger seats and other cabin equipment. The lower deck cargo doors to starboard are retained, measuring 2.69 x 1.84 m (8 ft $9\frac{29}{32}$ in x 6 ft $\frac{7}{16}$ in) for the No.1 door and 2.69 x 1.73 m (8 ft $9\frac{29}{32}$ in x 5 ft 8⅛ in) for the No.2 door; so is a equipment bay door 0.8 x 1.36 m (2 ft 7½ in x 4 ft 5½ in). A 4.85 x 2.875 m (15 ft 11 in x 9 ft 5 in) upward-opening cargo door is located ahead of the port wing. A compartment behind the flightdeck accommodates three seats for cargo attendants and a crew rest area with two folding cots. The upper deck cargo hold is 44.935 m (145 ft 8 in) long, with a floor area of 245 m^2 (2,637.4 sq ft) and a volume of 580 m^3 (20,485 cu ft).

Wings: Cantilever low-wing monoplane wings of basically trapezoidal planform with a trailing-edge kink, moderate sweepback and dihedral. The wings utilise a supercritical airfoil; they have a high aspect ratio and feature large upturned winglets with a kinked leading edge which increase the lift/drag ratio. An active system for damping the wings' elastic oscillations makes it possible to considerably lessen the stresses caused by air flow (this helps increase the service life of the aircraft). The wing structure incorporates a combination of high-strength metal alloys, composite materials, honeycomb structures used in the manufacture of the leading edge and trailing edge parts of

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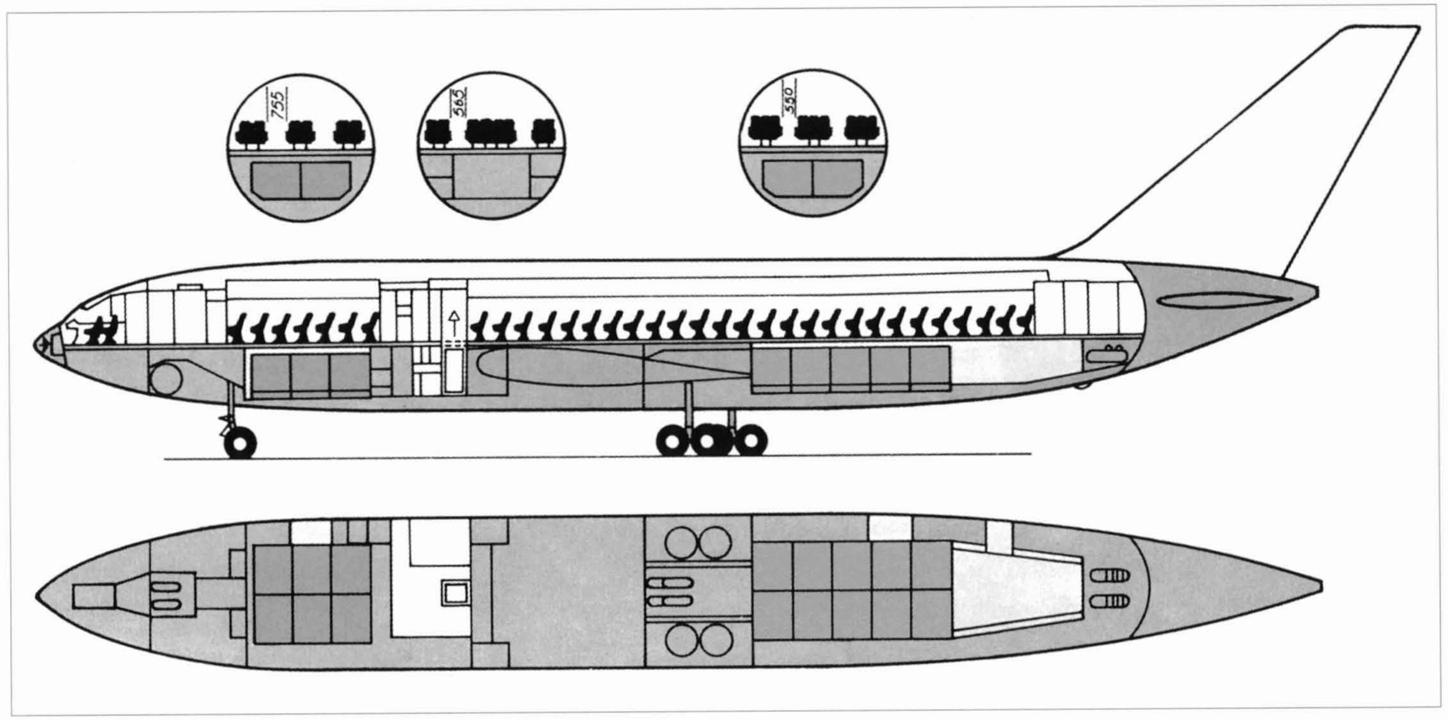

Above: This drawing shows the IL-96-300's interior layout. The aisle widths are 755, 565 on 550 mm (29¾, 22¼ and 21⅝ in) respectively.

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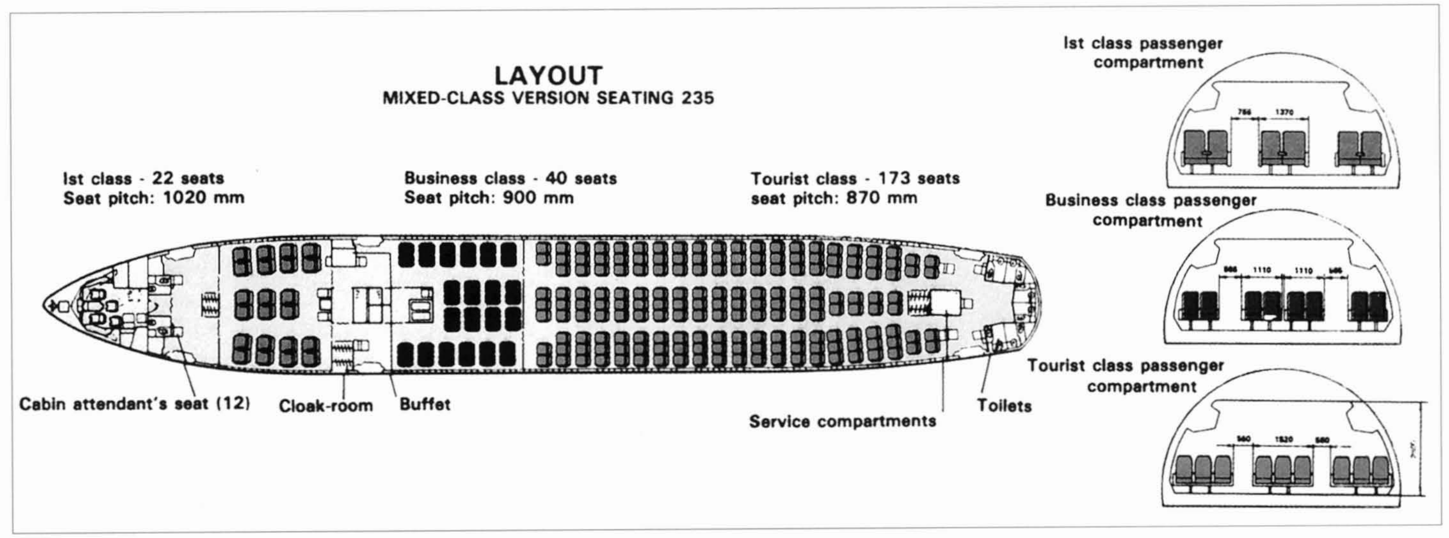
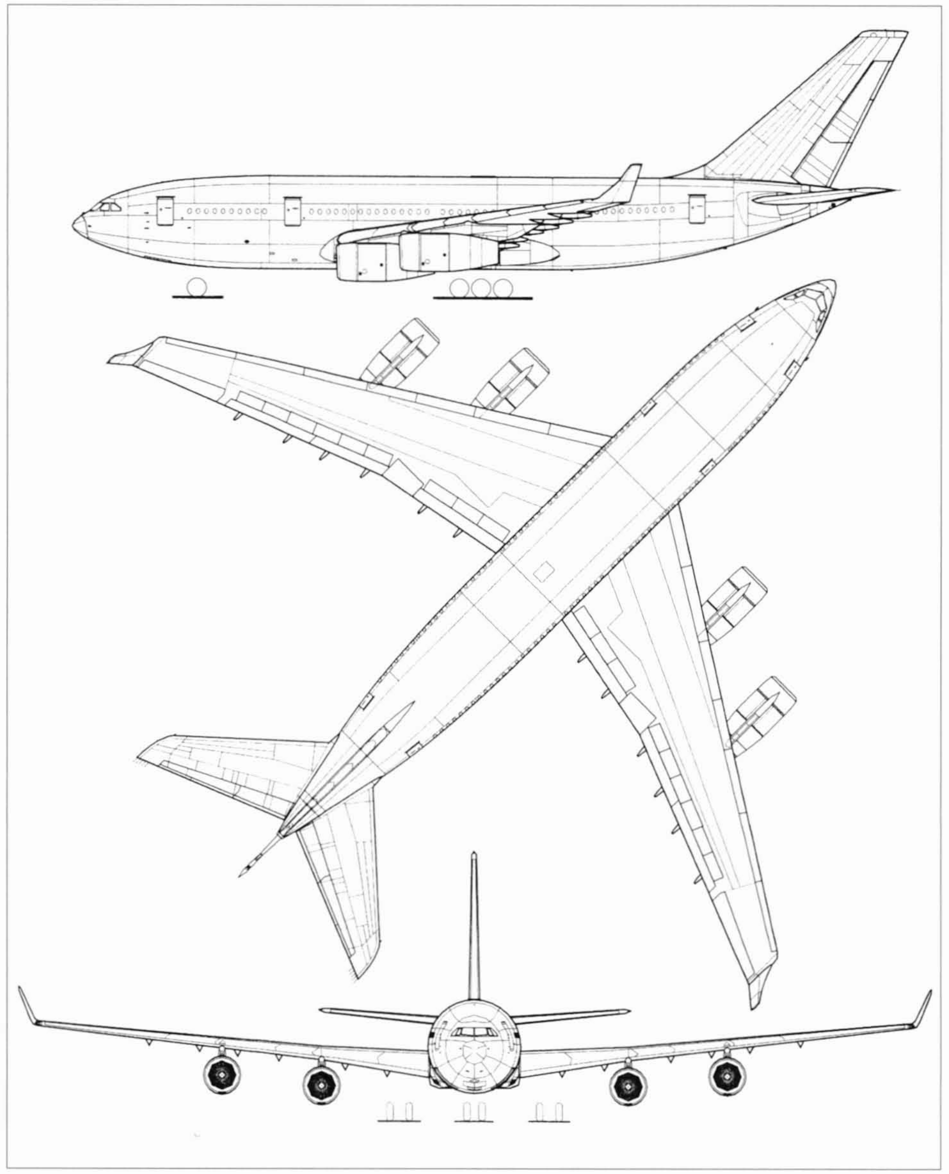


One of the IL-96's possible seating arrangements was this 235-seat layout.



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A three-view of the IL-96-300.

Specifications of the IL-96-300 airliner

Engine type	PS-90A
Engine thrust, kgp (lbst)	4 x 16,000 (35,280)
Maximum number of passengers	300
Maximum payload, kg (lb)	40,000 (88,200)
Range with fuel reserves, km (miles):	
with a payload of 30,000 kg (66,150 lb)	9,000 (5,594)
with a payload of 15,000 kg (33,075 lb)	11,000 (6,837)
Cruising speed, km/h (mph)	850-900 (528-559)
Flight altitude, m (ft)	10,000-12,000 (32,800-39,360)
Take-off runway length required, m (ft)	2,300 (7,544)
Landing runway length required, m (ft)	2,000 (6,560)
Landing speed, km/h (mph)	260-270 (162-168)
Equipped empty weight, tonnes (lb)	117 (257,985)
All-up weight, tonnes (lb)	216 (476,280)

the wing, its high-lift devices and wheel well doors. This has enabled the designers to create a wing structure featuring a high level of perfection as regards aerodynamics and weight.

The wings are fitted with efficient high-lift devices: full-span seven-section LE slats (the two innermost sections are separated from the others by a gap), inboard double-slotted flaps and outboard single-slotted flaps. The wings are also provided with one-piece high-speed ailerons (between the flap sections), two-section outer ailerons, six-section outer spoilers/lift dumpers (also used for roll control) and three-section ground spoilers.

Tail unit: Conventional swept tail surfaces. The horizontal tail is identical to that of the IL-86, whilst the vertical tail area is greater due to the increase of the fin height by 1.5 m (4 ft 11 in); this increases directional stability in the case of a single-engine failure.

Landing gear: Similar to that of the IL-86, with a twin-wheel nose unit and three main units with four-wheel bogies located aft of the aircraft's CG, the centre unit being positioned further aft. All wheels have the same size – 1,300 x 480 mm (51.11 x 18.89 in), the tyre pressure being 11.5 kg/cm² (150.69 psi). The landing gear enables the aircraft to operate from most paved airfields.

Powerplant: Four Aviadvigatel' (Solov'yov) PS-90A turbofans. The PS-90 is a two-shaft turbofan with a modular design featuring a single-stage fan, a two-stage LP compressor, a 13-stage HP compressor, a can-annular combustion chamber with 12 flame tubes, a two-stage HP turbine, a four-stage LP turbine, a cascade thrust reverser with translating cowl and two-channel FADEC. Bypass ratio 4.36, cruise SFC 0.58 kg/kgp·h. The IL-96M and IL-96T are powered by four 17,030 kgp (37,550 lbst) Pratt & Whitney PW2337 turbofans with a single-stage fan, a four-stage LP compressor, a 12-stage HP compressor, an annular combustion chamber, a two-stage HP turbine, a five-stage LP turbine and a cascade thrust reverser with translating cowl. The engines are installed in pylon-mounted nacelles ahead of the wing leading edge. To ensure autonomous engine starting and supply of compressed air to the air conditioning system prior to the starting of the engines, the aircraft is fitted with a VSU-10 APU.

Control system: Triply redundant analogue fly-by-wire (FBW) controls with a mechanical back-up system.

Fuel system: All fuel is housed in nine main integral tanks – four in each of the wing outer panels and one in the wing centre section. The volume of fuel tanks of the IL-96-300 aircraft totals 150,000 litres (33.000 Imp gal). The fuel system is automated. Each engine is fed from the service section of its own tank. These sections are always filled with fuel which is fed by jet pumps.

Avionics and equipment: The piloting and navigation suite ensures fully automatic navigation in any weather over any area of the globe and enables the aircraft to perform ICAO Cat IIIA automatic landings. This permits three-crew operations, reduces the crew workload and enhances flight safety. The aircraft has a triply redundant inertial navigation system, satellite navigation devices and Omega radio navigation aids. The piloting and navigation suite includes an electronic flight instrumentation system (EFIS) with six colour CRT displays and a head-up display (HUD). The aircraft's ease of operation is enhanced by built-in test equipment (BITE) used during maintenance. The IL-96M and IL-96T are fitted with Rockwell Collins avionics.

IL-103 multi-purpose light aircraft

In 1988 a competition was held for the development of a new *ab initio* training aircraft. On the basis of the requirements posed by this competition a group of young specialists at the Ilyushin OKB headed by A. V. Poopkov developed at their own initiative the project of an aircraft powered by a single 210-hp engine. The project envisaged widening the scope of the aircraft's use by creating also a four-seat passenger version.

Ghenrikh V. Novozhilov supported the initiative of the young employees. The team working on the IL-103 project was augmented by highly qualified OKB specialists with experience in designing various types of aircraft. They rendered a lot of help in the comprehensive work concerned with evolving the IL-103's aerodynamic configuration and structural layout and developing the onboard systems. The designers took due account of the fact that, apart from *ab initio* training at flying schools and air clubs, the machine might be sold to private owners who, as a rule, would have relatively low flying skills; for this reason special attention was paid to flight safety. Many hours of wind tunnel testing were used to develop the wings' aerodynamic configuration and ensure stability and controllability at both positive and negative angles of attack. Much emphasis was put on making the IL-103 suitable for simple production techniques with a view to launching large-scale production and cutting the unit price to a level that was affordable for potential customers. The aircraft was to have simple handling, well within the capabilities of an inexperienced pilot. The crew and passengers were

Sergey Komissarov

This full-scale mock-up of the IL-103 painted red and white was displayed at the MosAeroShow '92.

accommodated in a spacious comfortable cabin affording excellent visibility. Much attention was paid to simplifying maintenance and repairs as much as possible.

When designing the IL-103, the choice of engine turned into a major problem. No Russian air-cooled piston engines in the required power class were in existence, and the designers were compelled to opt for the US-manufactured Teledyne Continental Motors IO-360ES2B flat-six engine rated at 210 hp. The horizontally opposed engine fitted well into a streamlined forward fuselage and conferred aesthetically pleasing contours upon the machine. Installing a reliable engine with a long service life enabled the IL-103 to be operated in various climatic conditions from different kinds of airfields including unpaved surfaces. The aircraft can be fitted with avionics both of Russian and Western manufacture which enable the aircraft to fly along predesignated air routes at specified flight levels.

The IL-103 was unveiled in mock-up form at the MosAeroShow '92 from 11th to 16th August 1992; it was a low-wing monoplane with a fixed cantilever spring-type tricycle undercarriage. The aircraft had an all-metal aluminium alloy structure with detachable wings, fin and tailplane. The engine drove a Hartzell BHC-C2YF-1BF/F8459A-8R two-blade constant-speed metal propeller. The fuel system comprised two main fuel tanks in the wing roots with a total capacity of 200 litres (44.0 Imp gal) and a small supply tank in the fuselage. The cabin accommodated

Ilyushin Aviation Complex

RA-10300 (c/n 0101), the first prototype IL-103. The Ilyushin OKB's firstling in the general aviation class turned out to be an appealing aircraft.

Ilyushin Aviation Complex

Above: RA-10327, an early-production IL-103 used as a demonstrator. This example still has the original small wheels.

Sergey Komissarov

Above: Pretty soon after production entry the IL-103 received larger wheels as standard on all three landing gear units to improve rough-field capability, as illustrated by RA-61919 of IL-Service at the MAKS-2001 airshow.

Dmitriy Komissarov

Above: RA-10323, the IL-103-10 prototype, at the MAKS-97 airshow. Note the Le Bourget code.
Below: The other export version, the IL-103-11, is exemplified by RA-10324 at Kubinka AB on 8th August 1999.

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two forward-folding seats side by side at the front and a bench seat for two adults or three children at rear. Access to the cabin was provided by two gull-wing window/doors hinged on the canopy centreline. The cabin was ventilated and heated. A baggage compartment with a port side door was located aft the rear seat.

The avionics include a VHF radio and an ATC transponder. The IL-103-10 export version fully cleared for instrument flight rules flying along existing airways has a Bendix/King KX 165 nav/com/glideslope radio (replacing Russian radios) and a KT 76A transponder. It is equipped with VOR/ILS, KN 63 DME, KMA 24 audio control/MKR, KCS 55A compass and encoding altimeter. The IL-103-11, a simpler export version, features an MKS-1 compass and Bendix/King KR 87 ADF and KLN 89B GPS.

The IL-103 made its maiden flight on 17th May 1994 with test pilot I. I. Goodkov at the controls. At an AUW of 1,310 kg (2,882 lb) it could carry a 400-kg (880-lb) payload – one pilot and three passengers – over a distance of 1,000 km (621 miles) at a cruising speed of 220 km/h (137 mph) at an altitude of 3,000 m (9,840 ft). The take-off run was 280 m (918 ft) and the landing run 220 m (721 ft). The aircraft earned high praise from test pilots; accordingly, a decision was taken to put it into production at the Lookhovitsy Aircraft Production and Test Facility (LAPIK – *Lookhov**its**kiy aviatsi**on**nyy proiz**vod**stvenno-ispy**tah**tel'nyy **kom**pleks*). The first production IL-103 took to the air at Lookhovitsy-Tret'yakovo as early as 30th January 1995.

With several aircraft flying, the certification tests were conducted on a large scale. On 15th February 1996 the Ilyushin Aviation Complex received the Russian type certificate for the IL-103; it stated that the type design fully met the AP-23 airworthiness standards harmonised with the US FAR-23. Virtually at the same time the work was conducted for the purpose of making the IL-103 FAR-23 compliant. Joe Miss, chief certification pilot of the US Federal Aviation Administration, also rated the IL-103's performance highly, and on 9th December 1998 the IL-103 received its US type certificate. This work formed the basis for the mutual recognition of airworthiness standards and certification procedures in Russia and the USA.

The IL-103 was bought by several foreign countries (ten were delivered to Peru and Belarus before 2002; further sales were made to South Korean Air Force and to Laos). Pilots and technicians assess this machine as simple and easy to handle, posing no problems in maintenance and meeting all the present-day requirements specified for a trainer, sports and touring aircraft.

The Ilyushin Aviation Complex, together with LAPIK which has mastered series production of the IL-103, continues its work on perfecting the machine. This work is aimed at widening the aircraft's operational envelope and adapting the aircraft to performing various duties in the national economy; there are plans for fitting the aircraft with a more powerful engine and a retractable undercarriage. Plans were in hand for developing an ambulance version and a pilot and navigator training version.

The following versions of the IL-103 exist:

IL-103-01 all-purpose lightplane

This is the baseline VFR version for the domestic market. Production models may differ in certain respects, such as the installation of a ski undercarriage (tested on the first prototype), deletion of the second set of controls, provision of a longer baggage hold for such items as skis, installation of an extra fuel tank instead of the rear bench seat etc.

IL-103-10 all-purpose lightplane

Export version with fully upgraded avionics suitable for international airways navigation.

IL-103-11 all-purpose-lightplane

Export version with partly upgraded avionics suitable for local air navigation.

IL-103SKh agricultural aircraft

This version (***sel'**skokho**zyai**stvennyy* – agricultural) first flew on 29th March 2000. A hopper for chemicals replaces the rear seats; it is separated by a bulkhead from the pilot's compartment which is provided with ventilation. The unregistered prototype was exhibited at the MAKS-2001 airshow from 14th to 19th August 2001. The Uzbekistan government announced a requirement for 100 IL-103SKh crop-sprayers in late 1999, but plans for series production have not materialised so far.

IL-103LL testbed/research aircraft

The third prototype, RA-10303 (c/n 0104?), was converted LII and the State Research Institute for Aircraft Systems (GosNII AS) as the IL-103LL (*le**ta**yushchaya labora**to**riya*, 'flying laboratory') intended for testing and fine-tuning avionics – primarily data display systems to be fitted to various types of aircraft. The aircraft was exhibited at the MAKS-2003 airshow from 19th to 24th August 2003.

IL-103 environmental monitoring aircraft

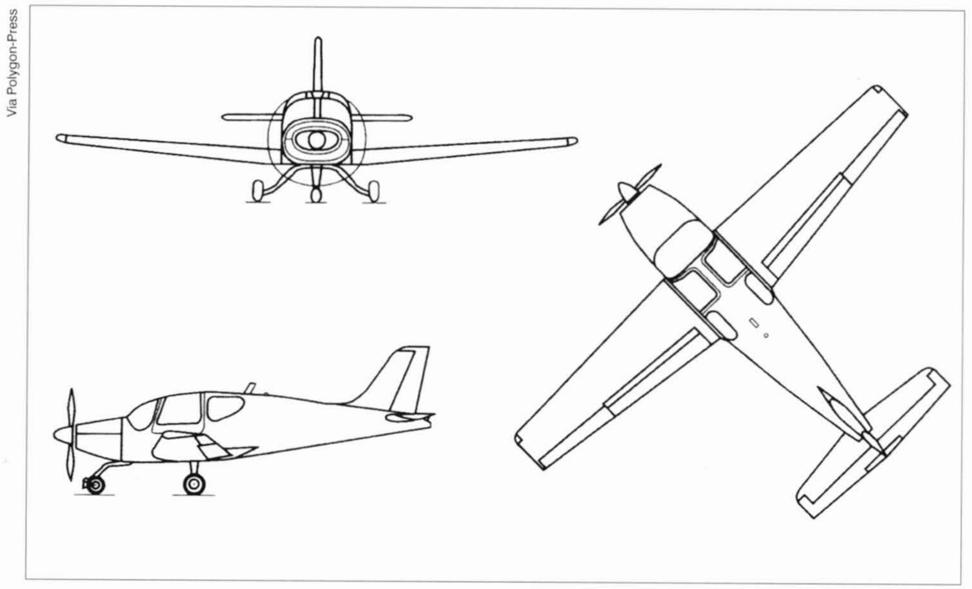
A single IL-103 (c/n 0205) configured as an environment monitoring aircraft with sensors in the baggage compartment was exhibited at the MAKS-99 airshow from 19th

Dmitriy Komissarov

Above: IL-103 c/n 0205 was outfitted as an environmental survey aircraft for the Ecology Fund of Russia. It is seen here at the MAKS-99 airshow; it was subsequently registered 01577 ФЛАРФ (ie, 01577 FLARF).

Dmitriy Komissarov

Above: At a late stage of its flying career, the third prototype (RA-10303) was converted into the IL-103LL avionics testbed for exploring new cockpit data presentation techniques. It is seen here in the static park of the MAKS-2003 airshow; note the non-standard antenna supplanting the anti-collision light.



Via Polygon-Press

A three-view drawing of the IL-103.

Sergey Komissarov

Above: The prototype of the IL-103SKh crop sprayer version at the MAKS-2001 airshow.

Ilyushin Aviation Complex

If necessary the IL-103 can be equipped with skis, as illustrated by the first prototype.

to 24th August 1999 by the Federal Ecological Fund. The unregistered machine (later registered 01577 ФЛАРФ, that is, 01577 FLARF) carried 'Ecology of Russia' titles.

Specifications of the IL-103 light aircraft

Wing span	10.56 m (34 ft 7¾ in)
Length overall	8.00 m (26 ft 3 in)
Wings, gross	14.71m^2 (158.4 sq ft)
Weight empty	900 kg (1,984 lb)
Max payload	270 kg (595 lb)
Max take-off weight (utility version)	1,285 kg (2,832 lb)
Max level speed	220 km/h (137 mph)
Cruising speed	180 km/h (112 mph)
Take-off run	380 m (1,250 ft)
Landing run	320 m (1,050 ft)
Max range at cruising speed	800 km (497 miles)

IL-114 regional airliner

In the early 1980s, after thoroughly analysing the development prospects of different classes of airliners and summarised the more than thirty years' experience of IL-14 operations, the Ilyushin OKB came up with the initiative of creating a new regional airliner, the IL-114. This idea met with support in the Ministry of Civil Aviation. Although the OKB barely coped with the work on the IL-96-300, it decided to concurrently undertake development of a new regional airliner eloquently designated IL-114.

Since the 1960s the An-24 airliner was widely used for passenger transportation on regional services. The aircraft had a good track record but was already obsolescent by the early 1980s; also, the fleet of these aircraft began to dwindle as the An-24s started running out of service life. The IL-114 was intended as a replacement for the An-24; it was envisaged for use primarily on high-intensity regional services and on some low-intensity trunk routes.

In accordance with the specification issued by MGA the IL-114 was to carry no fewer than 60 passengers over a distance of 1,000 km (621 miles) with a cruising speed of 500 km/h (311 mph) at an altitude of 6,000 to 8,000 m (19,680 to 26,240 ft).

The IL-114 had to meet specifications that differed in some respects from the specifications issued for similar aircraft abroad. For example, it was to operate from relatively small airfields with both paved and unpaved runways; this would enable it to be used in widely different regions. In addition, the aircraft's equipment was expected to ensure self-contained operation at poorly equipped airports. The designers were tasked with creating an aircraft which, while featuring an exceeding simplicity of design, would be provided with in-built airstairs and an APU and would afford easy and prompt access to all units and parts requiring scheduled maintenance without using maintenance platforms. It was also stipulated that the IL-114 should be capable of being operated at night and in adverse weather conditions. To meet this requirement, the IL-114 was fitted with an avionics suite which enabled it to take off and land in ICAO Cat.II conditions.

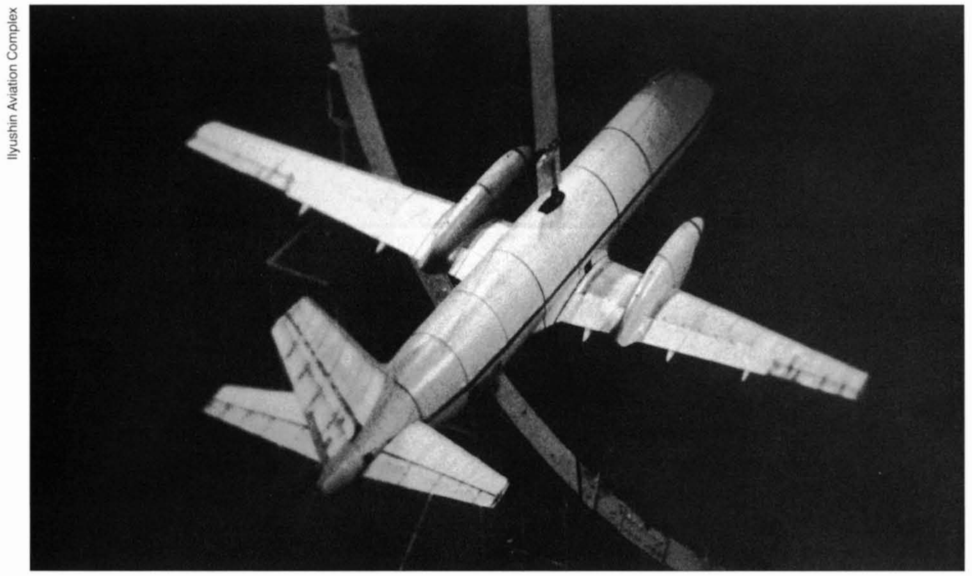
All these multifarious requirements dictated the choice of the IL-114's layout, required engine power, dimensions and weight, and special design features – that is, the choice of everything that ensures the stipulated flight and field performance. The required level of aerodynamic perfection was achieved by incorporating a number of scientific and technical features developed in co-operation with TsAGI. The IL-114's wings had a high aspect ratio and improved airfoil sections; the results of wind tunnel tests were used to improve the local aerodynamics in the area of wing/fuselage and wing/engine nacelle junctions. The engine nacelles, flap track fairings and various superstructures received improvements in their shape. Measures were taken to reduce the clearances between stationary and moving surfaces and to seal gaps. The IL-114's fuel efficiency was enhanced by optimising flight modes and by carefully selecting the characteristics of the aircraft and its systems that would match those of the engines.

Much emphasis was placed on reducing structural weight. This was achieved by refining the airframe and onboard systems design, by using new materials, more lightweight items of equipment. Comprehensive experimental studies were conducted in order to ensure the required strength, service life and survivability of the airframe; testbeds and test rigs were used for the development of various units and systems.

The designers had to tackle a double task: to make all units and assemblies of the IL-114 as simple as possible while ensuring their utmost reliability, operational convenience and ease of maintenance. Thus they opted for a manual control system without actuators. The hydraulic system pumps consume no electric power in flight because the systems actuated by hydraulics function only on the ground and during take-off and landing. To reduce the landing gear retraction time, the power of both hydraulic systems is used by means of automatically coupling them for a short time through interconnecting valves.

As was the case with other Ilyushin aircraft, during the development of the IL-114 special attention was devoted to ensuring dependability and flight safety. The way to achieve this consisted of using fail-safe airframe structures and ensuring sufficient fatigue strength. In addition, all functional systems and units affecting flight safety are provided with the requisite degree of redundancy and are manufactured using proven materials. The aircraft systems are located in such a way that the failure of one system does not affect the functioning of other systems. The IL-114's equipment enables it to perform flights in conditions of icing and storm clouds; the aircraft is provided with fire protection and fire suppression means. To provide prompt documentary record of systems and units which might have given problems in flight, there is an onboard printer which issues a printout listing all failed systems and units to be used by ground maintenance personnel and the crew. This makes it possible to take the correct decision concerning the machine's readiness for departure from an intermediate airport and reduces the time needed for searching out the trouble spots.

Reducing the ambient noise to prescribed levels is achieved by using 2,500-ehp Klimov TV7-117S turboprops developed under A. A. Sarkisov with SV-34 low-noise six-blade propellers and by synchronising their rotation with regard to rpm and phases. Reduction of the cabin noise level is achieved by a large (970 mm; 38¼ in) clearance between the propellers and the fuselage sides and by lining the cabin walls with soundproofing panels. This effect is further enhanced by the special features of the passenger cabin interior designed to damp vibrations and by lowering the speed of the airflow in the air conditioning system ducts.



Ilyushin Aviation Complex

Above: An instrumented model of the IL-114 in the TsAGI T-101 wind tunnel. The model was manufactured in Yugoslavia as part of the intended international co-operation in building the aircraft.

ITAR-TASS

Above: This full-scale mock-up of the IL-114 was unveiled in March 1989. No real IL-114 ever wore Aeroflot colours – unfortunately. Note the blue/white fin.

Ilyushin Aviation Complex

CCCP-54000, the first prototype IL-114, during a test flight. Note the two windows ahead of the propellers' plane of rotation (a feature of this particular example) and the test equipment sensor in the window aft of the emergency exit.

Ilyushin Aviation Complex

Above: CCCP-54001, the ill-fated second prototype which crashed on 5th July 1993 as RA-54001. Note the different colour scheme and the extra window ahead of the propellers' plane of rotation.

AVICO-Press

Above: RA-91005 (c/n 1043800207), the prototype of the IL-114T freighter. Note the three cabin windows where seats for persons accompanying the cargo are located.

AVICO-Press

The open cargo door of the IL-114T with the two actuating rams. The cabin is wide enough to swallow LD-3 containers, as this photo testifies.

Faced with the reduction of the An-24 fleet, the Soviet Ministry of Civil Aviation was very much in need of the IL-114. More than 600 IL-114s were to be built for Aeroflot, still functioning as a single entity, before 2000, and the first flight of the IL-114 was planned for late 1988.

However, construction of the first prototype IL-114 in co-operation with the Tashkent Aircraft Production Association named after Valeriy P. Chkalov (TAPO – *Tash**kent**skoye aviats**ion**noye proiz**vod**stvennoye obyedi**nen**iye*) encountered difficulties and was falling behind schedule. This was due to the ethnic conflicts which had taken place in Uzbekistan in 1988-89. Ethnic Russians from the TAPO's qualified technical staff started leaving the plant to emigrate to Russia. The work almost came to a standstill. At the cost of great efforts the plant's administration succeeded in overcoming the difficulties associated with the personnel, and in the summer of 1989 the wings of the first IL-114 were delivered to Moscow. However, they was manufactured to such a low production standard that some time had to be spent eliminating the obvious faults.

The first prototype (CCCP-54000, c/n 0101) was completed by the end of 1989 and ground tests began. Nikolay D. Talikov was appointed chief designer of the IL-114; A. V. Manokhin was project engineer and the ground crew was headed by Yuriy N. Grevtsev, a specialist of great experience who had previously headed ground crews for the testing of the IL-18, IL-38 and IL-76.

The main problem that arose in the process of the pre-flight preparation was: could the first flight of the IL-114 be performed from Moscow's Central airfield (Khodynka)? The main apprehensions were caused by the TV7-117S engine which was considered not yet 'ripe' for flight testing, to say nothing about the first flight from an airfield located in the centre of the city. Therefore, CCCP-54000 was dismantled in early February 1990 and transported to Zhukovskiy where it was reassembled; this was followed by system checks and engine runs lasting for many hours. V. S. Belousov, Merited Test Pilot of the USSR, was appointed crew captain, with A. K. Minchonok as co-pilot and V. I. Titov as flight engineer.

On 29th March 1990, after the completion of the usual programme of taxi runs, high-speed runs and brief hops on the runway at Zhukovskiy, the General Designer, specialists of the OKB and co-operating organisations, and the crew reported to the Presidium of MAP's Methodological Council that the aircraft was ready to fly. On the same day the crew captained by V. S. Belousov performed the first flight on the IL-114. This

Ilyushin Aviation Complex

UK 91009 (c/n 1063800202), the prototype of the 'Westernised' IL-114-100. The different shape of the nacelles housing PW127H engines is readily apparent.

machine was used for performance testing, including field performance checks. The very first flights demonstrated that the designers had succeeded in creating a regional airliner with high fuel efficiency: its fuel burn was reduced to half the fuel burn of its predecessor, the An-24.

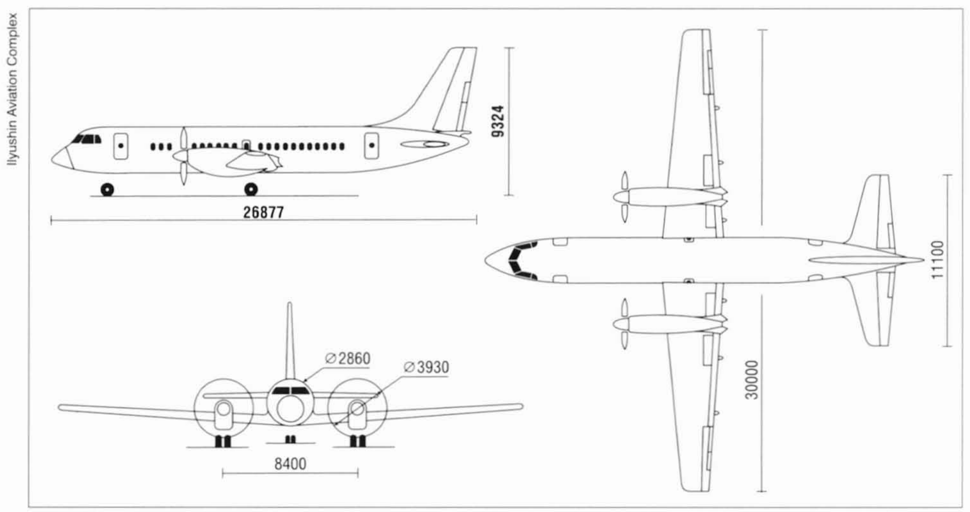
The testing of the IL-114 proceeded with difficulties. By the end of 1990 the aircraft performed 83 flights, logging 56 hours and 18 minutes. The flights were accompanied by numerous failures of the TV7-117S engines and of the TsPNK-114 digital flight/navigation avionics suite. Efforts undertaken by the General Designer, by designers of the engine and the EFIS/navigation suite, and by the administration of the enterprises engaged in the IL-114 programme, proved to be of no avail in the conditions when the economic and political situation in the country became simply unpredictable. An attempt was made to enlist the help of a Commission of the Supreme Soviet of the USSR to try to eliminate the causes of the delays in the IL-114 programme, but the Commission went no further then just acknowledging the difficult situation.

Assembly of the second IL-114 prototype also was an arduous business. Suffice it to say that its first flight was made possible only by transplanting from the first prototype some units which had not been delivered in time by subcontractors. For this reason the testing of the first IL-114 prototype had to be suspended in November 1991.

The first flight of the second prototype (CCCP-54001, c/n 0103) took place on 24th December 1991. This time the take-off was performed from Moscow-Khodynka, which made the choice of the crew a matter of critical importance. Merited Test Pilot Igor' R. Zakirov was appointed crew captain, the role of first officer was fulfilled by Stanislav G. Bliznyuk, chief of the OKB's flight test department who had a vast experience of performing take-offs and landings in different aircraft on this airfield. After ferrying the aircraft to Zhukovskiy a series of test flights was started for the purpose of certifying the flight/navigation avionics suite, the electrical system, the radio equipment, assessing the flightdeck ergonomics and fulfilling other test programmes. On 7th August 1992 the crew captained by I. R. Zakirov performed a flight on the first production IL-114. This machine was intended for testing and development of the powerplant and assessing the functioning of onboard systems at high and low ambient temperatures.

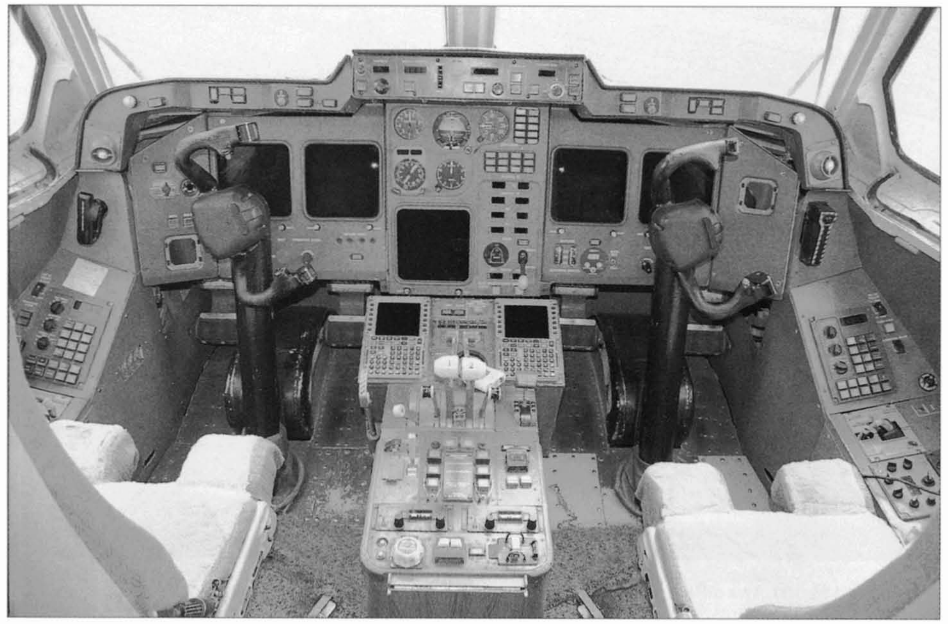
Certification tests of the IL-114 proceeded slowly. This was due to the lack of funding for the enterprises which developed and delivered the aircraft's systems and to inadequate support for flight testing in accordance with various certification programmes. These difficulties were compounded by the problems associated with the dissolution of the Soviet Union. The Tashkent plant which had spent so much effort on overcoming difficulties associated with launching the IL-114 into production turned out to be in another state, and customs duty problems cropped up in addition to the previous financial problems.

Nevertheless, the test went on, and by the summer of 1993 the IL-114 aircraft performed more than 580 sorties. Though various malfunctions took place from time to time, on the whole the aircraft and its onboard systems functioned reliably enough. Against this background it came as a complete surprise when the second prototype (by then reregistered RA-54001) crashed at Zhukovskiy on 5th July 1993, killing seven of the nine occupants. A commission was formed to investigate the causes of the accident; test flights of the IL-114 were suspended. According to the conclusions at which the 'tin kickers' arrived, *'...the crash was caused by a malfunction in the electronic part of the propeller control*



Ilyushin Aviation Complex

A three-view drawing of the IL-114.



Via AVICO-Press

The flightdeck of the IL-114 features five CRT displays and two control/indication units with keypads.

system. […] The ensuing unfavourable course of events resulting in the aircraft's collision with the ground was caused by the difficulties which the crew experienced in assessing the nature of the malfunction and its possible consequences. During the projecting of the aircraft and the compiling of its flight manual this malfunction was considered practically improbable; it had never occurred previously in the history of aircraft construction in our country.'

As if that weren't enough, the Moscow Aircraft Production Association named after Pyotr V. Dement'yev (MAPO – *Mos**kov**skoye aviatsi**on**noye proiz**vod**stvennoye obyedi**nen**iye*) at Moscow-Khodynka which was to be the second plant producing the type unexpectedly backed out – a move perceived by many at the OKB as betrayal.

Despite the tragic loss of the second prototype and its crew, the flight tests of the IL-114 resumed. The first Tashkent-built production machines were involved in the certification programme. They performed not only test flights but also demonstration flights in various regions of Russia and abroad. The tests were conducted by flight crews and testers of the Ilyushin Aviation Complex, GosNII GA, LII, TAPO and other specialists. The results of this comprehensive work were summarised on 24th April 1997 when the Air Register of the CIS Interstate Aviation Committee awarded a type certificate to the IL-114.

The Uzbek flag carrier Uzbekiston Havo Yullari (Uzbekistan Airways) was the launch customer for the IL-114, taking delivery of two. Since late 2002 the IL-114 has been operated in Russia as well by the Vyborg North-Western Air Transport Company.

AVICO-Press

The cabin of the IL-114 has a modern look, with enclosed overhead baggage bins and indirect lighting.

The special features incorporated in the IL-114's design, such as its considerable payload, long maximum range, the possibility of independent operations from relatively poorly equipped airfields, including unpaved airfields, in adverse weather conditions opened up the prospect of developing a family of specialised versions on the basis of the IL-114. The first of these was the IL-114T freighter.

IL-114T cargo aircraft

Experience of IL-114 operations gained by Uzbekistan Airways, as well as studies of the prospects of cargo transportation development on regional routes, demonstrated that there was a need for aircraft with a payload of up to 7 tonnes (15,430 lb). The cargo version of the IL-114 differed from the passenger machine in being equipped with a big cargo door 3.25 m (10 ft 8 in) wide and 1.715 m (5 ft 7½ in) high on the port side of the rear fuselage; it also featured a reinforced cargo floor fitted with detachable roller tracks for moving containers or pallets along the cargo cabin. Eight containers or pallets can be tied down to the floor by special folding locks. Their displacement in the event of a crash landing is prevented by special nylon belts (unofficially dubbed 'muzzles') which are attached to the floor rails.

In the forward fuselage, forward of the cargo cabin, there is a compartment for cargo attendants; it is fitted with two seats and a toilet. The compartment is separated from the cargo cabin by a smoke-proof curtain. The number of seats for cargo attendants can be increased to 16; in this case the smoke-proof curtain is moved aft, and the number of containers or cargo pallets carried by the aircraft is reduced to six.

As distinct from the baseline passenger version, the IL-114T (***trahns**portnyy*) uses a fly-by-wire control system with back-up mechanical linkage. To reduce the hinge moments, the control surfaces are aerodynamically balanced and the rudder and ailerons are provided with spring tabs. This makes it possible to preserve the controllability characteristics within the required limits in the event of a failure of the FBW system.

Initially placed on the Russian register as RA-91005, the IL-114T prototype (c/n 1043800207 – that is, year of manufacture 1994, 38 is a new code for TAPO, Batch 002, 07th aircraft in the batch) was built in Tashkent, its first flight taking place on 14th September 1996. The event was witnessed by U. T. Sultanov, Prime Minister of Uzbekistan, and the leaders of the Ilyushin Aviation Complex and TAPO. The aircraft was flown by a crew captained by Igor' R. Zakirov. Later the aircraft was reregistered UK 91005. Testing of the IL-114T freighter encountered difficulties caused by insufficient financing of the enterprises that had developed and built the aircraft. Nevertheless, the second IL-114T made its first flight on 30th September 1998.

This aircraft (UK 91004, c/n 1083800305) was delivered to the plant's own airline, TAPO-Avia, and used for cargo flights catering for the needs of the TAPO. Alas, during the morning of 5th December 1999 this machine crashed at Moscow-Domodedovo. The aircraft was taxying out for take-off when a gust of wind with a speed of 18 m/sec (36 kts) deflected the rudder to its extreme starboard position. The gust lock went into action and fixed the rudder in this position. The crew failed to grasp what had happened and was unaware of the fact that the rudder had got stuck in the extreme deflected state. They had the impression that the unusual position of the rudder was due only to the pressure of the crosswind, and requested permission for take-off. Immediately after lift-off the aircraft veered sharply, crashed through the concrete perimeter fence and exploded. Several TAPO employees were killed in the crash.

This accident prompted the designers to check once again the control system. It came to light that the rudder had got stuck in the deflected position because of failure by production personnel to strictly comply with the manufacturing documents when installing the rudder gust lock and the limiting quadrant. Despite this crash, work on the IL-114T is continuing, Russian air carriers being very much in need of this machine.

IL-114-100 regional airliner

In addition to the IL-114 airliner and the IL-114T cargo aircraft powered by TV7-117S engines, aircraft manufacturers of Russia and Uzbekistan created one more version of the baseline aircraft – the IL-114-100 airliner. This version aimed mainly at the export market is powered by 2,750-ehp Pratt & Whitney Canada PW127H turboprops driving Hamilton Standard six-bladed propellers of US manufacture.

The emergence of the IL-114-100 was due to the requirements of the market: foreign air carriers needed an IL-114 with engines with a longer service life than the Russian TV7-117S engines and relying on a well-developed network of servicing and operational support facilities. The PW127H was the engine that met the wishes of air carriers in the fullest degree; already at present these engines have a TBO of 6,000 hours (some examples have been in operation on a 'technical condition' basis and have logged 8,000 hours or more without being removed from the aircraft).

Although the performance of the IL-114-100 does not significantly differ from that of the baseline version powered by Russian engines, General Designer Ghenrikh V. Novozhilov took into account the wishes of potential customers and took a decision to start projecting the IL-114 version powered by the Canadian engines.

The contract for the installation of PW127Hs on the IL-114 was signed in the summer of 1997. The Ilyushin Aviation Complex transferred the manufacturing drawings to TAPO in the spring of 1998; slightly more than half a year later, in January 1999, a crew captained by test pilot I. I. Goodkov performed the first flight of the IL-114-100 prototype, UK 91009 (c/n 1063800202).

Bearing in mind the persistent funding difficulties, this rapid tempo of prototype construction was a remarkable achievement of the Uzbek aircraft constructors headed by TAPO General Director V. P. Kucherov. From the Russian side technical support for the manufacture of the IL-114-100 was provided by specialists of the Ilyushin Aviation Complex guided by Chief Designer N. D. Talikov.

Like the baseline IL-114, the IL-114-100 is offered to customers in two main versions of the cabin layout: a tourist-class configuration for 64 passengers and an enhanced comfort configuration with 52 seats in two separate compartments.

In June 1999 the IL-114-100 successfully had its world debut at the Paris Airshow. Ten IL-114-100s were ordered by Uzbekistan Airways. The aircraft also attracted the interest of air carriers in China, Pakistan, Vietnam, Laos, Malaysia, Bulgaria and Latvia. The CIS Interstate Aviation Committee type certificate was awarded on 27th December 1999.

AVICO-Press

One of the final assembly shops at the Tashkent Aircraft Production Corporation. The IL-114T prototype, RA-91005, is foremost, bearing the Le Bourget '97 exhibit code 336; IL-114T UK 91004 is next in line, together with at least six examples of the passenger version. Note the partially complete IL-76s at the far end.

AVICO Press

IL-114 UK 91001 (c/n 1013823024, f/n 0106) in the colours of launch customer Uzbekistan Airways at MAKS-95. This aircraft now flies in Russia as RA-91014 (see page 384).

Certification of the aircraft was expected to be completed in 2003.

According to some sources, a cargo version designated IL-114-100T was envisaged.

The IL-114-100 was preceded by a project designated IL-114PC (PC stands for P&W engines and Collins avionics) which had been developed with a view to starting licence production of this aircraft in South Korea as a joint venture with a local company. These plans failed to materialise, but the project served as a basis for the IL-114-100.

The baseline IL-114 has been developed into a whole family of aircraft intended for both civil and military purposes. They are briefly described below. Implementation of these projects depends on the market demands and financial resources of potential customers.

IL-114M airliner (project)

Bearing in mind the steady, albeit slow, growth of the volume of passenger traffic on regional services, virtually concurrently with the projecting of the baseline IL-114 work was started on its version, the IL-114M, with the number of seats increased to 72 and with extended range. This was achieved by stretching the fuselage, increasing the AUW and installing the more powerful TV7-117S Srs 3 engines or the US-manufactured 3,500-ehp Pratt & Whitney PW-150 engines.

Another source mentions the IL-114M as a 74-seat version powered by two Allison GMA-2100 turboprops driving Dowty propellers (a technical proposal).

IL-114MA airliner (project)

This is a version of the IL-114M with Pratt & Whitney Canada engines designed to carry 74 passengers at 600-650 km/h (373-404 mph) on 2,000-km (1,242-mile) stages.

IL-114T-200S (IL-114-N200C?) cargo aircraft (project)

This is a cargo version with a rear loading ramp. There has been some confusion about the spelling of the designations in advertising materials, producing variations such as IL-114T-200S and IL-114N-200C.

IL-114VT transport aircraft (project)

A projected variant with a rear loading ramp designated IL-114VT (presumably *voyenno-trahnsportnyy* [*samolyot*], military transport) has also been mentioned.

IL-114P maritime patrol aircraft (project)

The IL-114P (*patrool'nyy* – patrol, used attributively) is intended for patrolling coastline areas, territorial waters and the 200-mile economic exclusion zone. The operators' cabin located aft of the flightdeck is divided into two compartments. The forward compartment can accommodate service passengers or sick and wounded personnel, or palletised cargoes. The rear part of the cabin houses the mission avionics, two seats for the operators, a compartment for the relief crew, a galley and a toilet. The operators' seats are placed on both sides of the cabin and are provided with blisters for visual observation.

Two standard bomb racks are mounted under the wings. They can carry containers with various equipment, searchlights, a remote-controlled gun, a powerful loudspeaker, or rescue containers. The aircraft is provided with a round-looking radar, a thermal imaging device, a GPS equipment, a data link system and equipment for environmental monitoring and aerial photography.

IL-114MP maritime patrol aircraft (project)

Descriptions of this version vary. Sometimes the designation is spelled IL-114PM (M = *modifitseerovannyy* – modified). According to one source, this is a maritime patrol version based on the IL-114M powered by two Ivchenko AI-20 (!) or Allison GMA-2100 turboprops. It is intended for patrolling, searching, detecting, identifying, tracking and destroying submarines and surface targets. A technical proposal was prepared in 1999.

A published drawing shows the IL-114MP with a radome in the 'drooped' nose and a MAD 'sting' in the aft fuselage. The aircraft is intended for patrolling the 200-mile economic exclusion zone and detecting aircraft, surface ships and underwater vehicles intruding into this zone. It can remain on station at the distance of 300 km (186 miles) from its base for 8 to 10 hours; carrying up to 1,500 kg (3,310 lb) of sonobuoys for the detection of submarines. The aircraft is equipped with a sonar system, a thermal imager and electronic intelligence systems. Various types of armament can be carried on underwing racks.

IL-114PR patrol and electronic warfare aircraft (project)

This version, proposed in 1999, is powered by TV7-117S or PW127H engines. It is intended for patrolling, ELINT and electronic countermeasures (hence the PR for *patrool'no-razvedyvatel'nyy* – patrol/reconnaissance, used attributively).

IL-114PRP patrol and electronic warfare aircraft (project)

This version proposed in 1999 is powered by two TV7-117S Srs 2 or Pratt & Whitney PW150 engines. It is intended for patrol, ELINT and ECM duties.

IL-114FK photo mapping aircraft (project)

This is a photo mapping/cartographic survey version (FK = *fotokartograficheskiy*). The forward fuselage is patterned on the An-30 and features an extensively glazed navigator's station in the extreme nose, with the flightdeck raised above the upper fuselage contour. The weather radar is installed in a chin radome. The entry/cargo door is located in the forward end of the operators' cabin which has practically all windows deleted. The operators' cabin is provided with an emergency escape hatch. The aircraft is fitted with the TsPNK-114FK digital flight/navigation avionics suite ensuring automated navigation and automated control of the aerial cameras. The operators' cabin houses workstations for two operators and cameras for vertical, oblique and panoramic photography, as well as the *Trezoobets-K* (Trident-K) and *Raduga-V* (Rainbow-V) radar systems. The camera window for the AS-707 panoramic camera stands proud of the fuselage contours and is provided with a fairing. Modifications to the landing gear include increasing the wheel base by 250 mm (9⅞ in) and shifting the nose gear unit to port by 200 mm (7⅞ in).

Some Western publications have published reports about a military version of the IL-114FK intended to replace the An-30 and even the IL-20 reconnaissance aircraft. Presumably it differs from the civil version in the mission equipment (some drawings depict it as fitted with additional side fairings on the fuselage).

IL-114 ice reconnaissance aircraft (project)

This version of the IL-114 was studied in two variants (for visual and instrument ice reconnaissance respectively).

The former variant was intended for visual reconnaissance in the Arctic and Antarctic regions and over other sea areas with the use of low-altitude probing equipment and other visual means for monitoring the environment. It had a crew of eight and was equipped with two observation blisters measuring 78 cm (2 ft 6¾ in) in diameter. The operators' cabin is equipped with a camera port and a window for a laser profilograph. Equipment may include the Aquamarine radar device for measuring the thickness of the ice, a data link for transmitting ice charts, etc. The aircraft is equipped with movable searchlights for lighting the land or sea surface at night. It is intended for operations at altitudes between 8,000 and 100 m (26,240-330 ft).

The instrument ice reconnaissance aircraft has a bigger crew comprising 13-14 persons. It features a wider range of mission equipment which may comprise the Iceberg radar device for measuring the thickness of ice, a laser profilograph, a UHF air route radiometer, a scanning UHF radiometer, a cartographic computer, a side-looking radar, data link equipment etc.

For greater survivability during independent operations in the Antarctic region these aircraft need to be fitted with auxiliary onboard power sources and rescue equipment; they will feature a modified landing gear combining the wheels with retractable metal skis.

IL-114ORR fisheries reconnaissance aircraft (project)

The IL-114ORR (*okeahnskiy razvedchik ryby* – ocean fishery reconnaissance aircraft) is a follow-on to the late IL-18DORR intended for spotting fish shoals, determining the concentration of phytoplankton in the sea, assessing the stock of algae, taking stock of sea mammals, measuring the water temperature, compiling thermal field charts, and determining areas of pollution on the surface of the sea. The aircraft's mission equipment is to include instruments for infrared telemetry, laser detection, multizone aerial cameras. Hemispherical blisters will be used for visual observation and photography; aerial cameras will be provided with optically flat windows.

IL-114TOP ground attack (gunship) aircraft (project)

Development of this version was inspired by the successful use of 'gunships' by the US Air Force during the Vietnam war and other campaigns. The letters OP in the suffix stand for *ognevaya podderzhka* (lit. fire support); T may stand for *takticheskaya*, tactical. The aircraft's armament comprises two cannons installed in remote-controlled turrets under the fuselage. The turret located under the forward fuselage is fitted with a 120-mm (4.7-in) 2S23 'Nonna' (a woman's name) tank gun with 90 rounds of high-explosive/fragmentation ammunition; the turret under the rear fuselage carries the 30-mm (1.18 calibre) 2A42 selectable-feed cannon (as fitted to the BMP-3 infantry fighting vehicle and the Mil' Mi-28 and Kamov Ka-50 attack helicopters) with 1,100 rounds. Both cannon can be traversed to an angle of ±90° and deflected within 90° in the vertical plane. They are aimed and fired by two gunners whose workstations are located immediately aft of the flightdeck and fitted with aiming devices using TV cameras. The gunners' compartment is separated by a smokeproof curtain from the weapons compartment in which two operators ('gun crew') wearing gas masks service the weapons.

IL-114 IL-Sevmorgheo geophysical survey aircraft

The first prototype IL-114 (RA-54000) was converted into a geophysical survey aircraft for use by the GNPP Sevmorgheo (*Severnaya morskaya gheologiya* – Northern Marine Geology) science and production enterprise. The aircraft was fitted with magnetic anomaly detectors (with an MAD pod on the port wingtip) and gravimetric equipment and underwent testing at a test range. The results of these flight corroborated the aircraft's suitability for performing geophysical survey in distant sea areas of Russia's North and Far East. By August 1999 the mission equipment had been removed.

IL-114 radar testbed

In 2003 a specially equipped IL-114 was under construction at TAPO in response to an order from the St. Petersburg-based Radar-MMS science and production enterprise engaged in radar systems development. The aircraft was intended for flight testing and development of prototype items of electronic equipment and for performing a comprehensive survey of the Earth's surface using radar, photo and thermal imaging equipment. The survey is supposed to be performed at any time round the clock irrespective of the weather conditions and time of the year. A model bearing the registration RA-91018 showed this aircraft as fitted with big external housings (possibly SLAR) on the sides of rear fuselage.

IL-140 surveillance aircraft (project)

This derivative of the IL-114M airliner, powered by two AI-20 or GMA-2100 turboprops, revealed to be in project stage in October 2000, was proposed in 1999. It is a multi-sensor surveillance (tactical air control) aircraft intended to detect and identify air targets.

IL-140M multi-purpose patrol aircraft (project)

Based, likewise, on the IL-114M and proposed in 1999, this is a patrol, ecological monitoring and maritime SAR version.

IL-114 – other versions

Various other prospective versions have been briefly mentioned in publications; they include the IL-114-50 airliner with a seating for 52 passengers, a radio relay version and the IL-114 Combi passenger/cargo aircraft.

Dmitriy Komissarov

This model of a proposed radar technology testbed version of the IL-114 developed by the Radar-MMS company was displayed at the International Maritime Defence Show in St. Petersburg on 29th June 2003.

The IL-114 in detail

Type: Twin-turboprop regional airliner (IL-114 and IL-114-100) or freighter (IL-114T). The flight crew comprises two persons. The captain pilots the aircraft during the most critical stages of the flight (take-off and landing), controls the engines and systems, assists the first officer in solving navigation tasks. The first officer pilots the aircraft in cruise mode, is responsible for navigation and radio communication and controls the engines and systems following the captain's instructions.

Fuselage: All-metal semi-monocoque structure of circular cross-section with a maximum diameter of 2.86 m (9 ft 4½ in). The fuselage is built in five sections. There is a forward-opening plug-type door equipped with folding airstairs (stowed aft of the door on the port side of the forward fuselage, with an upward-opening baggage door opposite; two more plug-type service doors are located on the rear fuselage sides. Two overwing emergency exits are provided.

The passenger cabin can be fitted with up to 64 reclining seats four-abreast with a 450-mm (17¾ in) aisle. with a pitch of 780-750 mm (30¾-29½ in). Provision is made for the installation of a galley in the rear vestibule; there is a coat closet and a toilet in the rear part of the cabin. In addition, the passenger cabin houses a set of emergency rescue equipment. The passengers are catered for by a flight attendant whose jump seat is located in the rear vestibule.

The passengers' baggage and eventual supplementary cargo is accommodated on a rack just aft of the starboard side baggage door and in the rear cargo hold at the aft extremity of the cabin. The latter is used for cargoes and oversize or heavy baggage.

The IL-114T lacks most of the cabin windows, the overwing exits, the starboard forward and port rear service doors. Instead, it has an emergency exit opposite the entry door and a large upward-opening cargo door aft of the port wing. The window arrangement is door+3+1+cargo door to port and exit+3+1+1+door to starboard instead of door+3+6+exit+11+door on each side for the passenger versions.

Wings: Cantilever low-wing monoplane wings of trapezoidal planform; no sweepback, slight dihedral from the roots The wings carry dorsally-mounted engine nacelles. Aspect ratio 11, area 81.9 m² (881.65 sq ft); the choice of these parameters was dictated both by the specified performance and by the need to ensure operations from short runways.

The wings feature one-piece double-slotted extension flaps with a fixed deflector. Ailerons, each with a servo tab and a trim tab, are located outboard of them; four-section airbrakes deflecting 50° at the moment of touch-down to shorten the landing run. The first prototype had a single spoiler on each wing which deflected to an angle of 40°; they were intended for countering bank in the event of an engine failure. After the flight tests the spoilers were considered unnecessary and deleted.

Tail unit: Cantilever conventional tail surfaces with a swept vertical tail featuring a one-piece rudder (with a trim tab and a servo tab) and an unswept horizontal tail with trim tabs on the one-piece elevators. The dimensions and design features of the tail surfaces were chosen with a view to ensuring the requisite stability and controllability characteristics during a take-off with one engine inoperative.

Landing gear: Hydraulically retractable tricycle type, with twin wheels on each unit. All units retract forward; emergency extension by gravity. Oleo-pneumatic shock-absorbers. Tyre size 620 x 80 mm (24.4 x 3.15 in) on nosewheels, 880 x 305 mm (34.65 x 12 in) on mainwheels. Nosewheels steerable through ±55°. Disc brakes on mainwheels. All wheel wells closed by two pairs of lateral doors; the main doors open only when the gear is in transit.

Powerplant (IL-114/114T): Two 2,500-ehp Klimov (Sarkisov) TV7-117S turboprops. The engine has a modular design with a compressor featuring five axial stages and one centrifugal stage, a reverse-flow annular combustion chamber, a two-stage power turbine, a two-stage free turbine, two accessory gearboxes and FADEC.

The engines are installed in nacelles on the wings' upper surface, driving Aerosila SV-34 low-noise six-blade propellers of 3.6 m (11 ft 9¾ in) diameter turning clockwise when seen from the front; the propellers feature carbonfibre reinforced plastic blades and an automatic feathering system. The location of the engines relative to the fuselage was selected with a view to reducing the cabin noise level and minimising the yaw in the event an engine failure.

The engines are started by compressed air supplied by a VD-100 APU in the fuselage tailcone. The IL-114-100 has Pratt & Whitney Canada PW127H engines and an Allied Signal APU.

Avionics and equipment: The IL-114 is equipped with a TsPNK-114 digital flight/navigation avionics suite which ensures automated and manual navigation along well-equipped and poorly equipped routes of local services in the daytime and at night and in any season, as well as ICAO Cat.I and II approach and landing. All means of information display and indication and onboard system controls are combined into an integrated information and control system, with all flight and navigation information presented at five colour CRTs on the instrument panel in the flightdeck. The IL-114-100 features Western avionics.

There are two independent hydraulic systems with a pressure 210 kg/cm² (3,000 psi), for landing gear actuation, wheel brakes, nosewheel steering, airbrakes and flaps. The electric system uses three-phase 115/220 V 400 Hz AC supplied by a 40-kW alternator on each engine; secondary 24 V DC system. Wing and tail unit leading edges are de-iced electrically by a patented electro-pulse system. Electric de-icing is used for the propeller blades, windscreen and pitots; the engine air intakes are de-iced by engine bleed air.

Specifications of the IL-114 airliner

Type	IL-114	IL-114T	IL-114-100
Engine type	TV7-117S	TV7-117S	PW127H
Take-off power, ehp	2 x 2,500	2 x 2,500	2 x 2,750
Wing span	30.0 m (98 ft 5 in)	30.0 m (98 ft 5 in)	30.0 m (98 ft 5 in)
Wing area, m² (sq ft)	81.9 (881.65)	81.9 (881.65)	81.9 (881.65)
Length overall	26.875 m (88 ft 2 in)	26.875 m (88 ft 2 in)	26.875 (m 88 ft 2 in)
Maximum take-off weight, kg (lb)	23,500 (51,817)	23,500 (51,817)	23,500 (51,817)
Maximum number of passengers	64	–	64
Maximum payload, kg (lb)	6,500 (14,332)	7,000 (15,435)	6,500 (14,332)
Practical range, km (miles)			
with the max number of passengers	1,000 (621)	n.a.	1,400 (870
with 52 passengers	1,800 (1,119)	n.a.	2,200 (1,367)
with a payload of 6,000 kg/13,230 lb		1,000 (621)	
with a payload of 1,500 kg/3,307 lb	4,800 (2,983)	4,800 (2,983)	5,000 (3,107)
Cruising speed, km/h (mph)	500 (311)	500 (311)	500 (311)
Cruising altitude, m (ft)	7,600 (24,930)	7,600 (24,930)	7,600 (24,930)
Take-off distance, m (ft)	1,500 (4,920)	1,500 (4,920)	1,350 (4,430)
Landing distance, m (ft)	1,450 (4,760)	1,450 (4,760)	1,350 (4,430)

AIRLINER AND TRANSPORT PROJECTS

5

IL-16 jet airliner

It is a little-known fact that the first Soviet jet airliner, the Tu-104, was born in a competition with a similar project from Ilyushin's OKB. Ilyushin's contender was the IL-16, the work on which was started in 1952 at the Chief Designer's initiative. Unlike the Tu-104, it was not a bomber derivative but an all-new design; yet it closely resembled its rival in the overall configuration, being a low-wing monoplane with swept wings and tail surfaces and with the engines flanking the fuselage. However, the powerplant was different. Having considered a version with two 8,000-kgp (17,640-lbst) Mikulin AM-3 turbojets, Ilyushin gave preference to a four-engined variant and finally selected the AM-11 turbojet rated at 3,750 kgp (8,270 lbst) for take-off. Actually, Ilyushin's contender was closer to the de Havilland DH.106 Comet than to the Tu-104, the engines being buried in the wing roots in side-by-side pairs. The main landing gear units retracted into the wing centre section, leaving the wing trailing edge free from undercarriage fairings as on the Tu-104.

The work on the IL-16 was officially endorsed in April 1955. Initially it was to be a 40-seat airliner with a range of 1,600 km (994 miles). However, the designers came to the conclusion that considerations of economic efficiency dictated an increase of the seating capacity to 80-85, and of the range to 3,000 km (8,268 miles). A comprehensive programme of wind tunnel tests was put into effect, a passenger cabin mock-up was built and the preparation of manufacturing drawings got under way. However, the IL-16 never reached the hardware stage. The successful testing of the Tu-104 deprived the IL-16 of any chances, and on 30th November 1955 all work on the project was halted.

IL-60 military transport (I)

The Ilyushin OKB embarked on its first design of a turbine-engined military transport aircraft as early as 1960. In response to a specification issued by the Soviet Air Force the OKB developed a project of a military transport powered by four 8,500-ehp turboprops. On 26th February 1960 the project was submitted for consideration to GKAT Chairman Pyotr V. Dement'yev. This was a shoulder-wing monoplane with wing-mounted engines. Its pressurised cargo hold measured 4,0 x 4,0 m (13 ft 1½ in x 13 ft 1½ in) in cross-section, had a length of 30 m (98 ft 5 in) and featured a rear cargo hatch closed by a loading ramp and a three-section door. The IL-60 was intended for transporting cargoes with a total weight of up to 40 tonnes (88,190 lb) over a distance of 3,600 km (2,237 miles); with a 10-tonne (22,045-lb) payload its range was 8,700 km (5,407 miles). The machine was to have an AUW of 124.2 tonnes (273,860 lb). This project was submitted together with Ilyushin's proposal on the development of the IL-62 airliner. Obviously the government bodies came to the conclusion that simultaneous work on the two designs would overtax the OKB's resources. Ilyushin was entrusted with the development of the airliner, whilst another design bureau – OKB-473 led by Oleg K. Antonov – was tasked with creating a new military transport aircraft (which eventually emerged as the An-22).

IL-60 military transport (II)

There is a brief mention in one source of another military transport aircraft project also dated 1960 and also bearing the designation IL-60. It differs from the project described above in being powered by turbojets, not turboprops. If this is not just a mistake, one may surmise that the two projects represent alternative approaches to meeting the same basic specification.

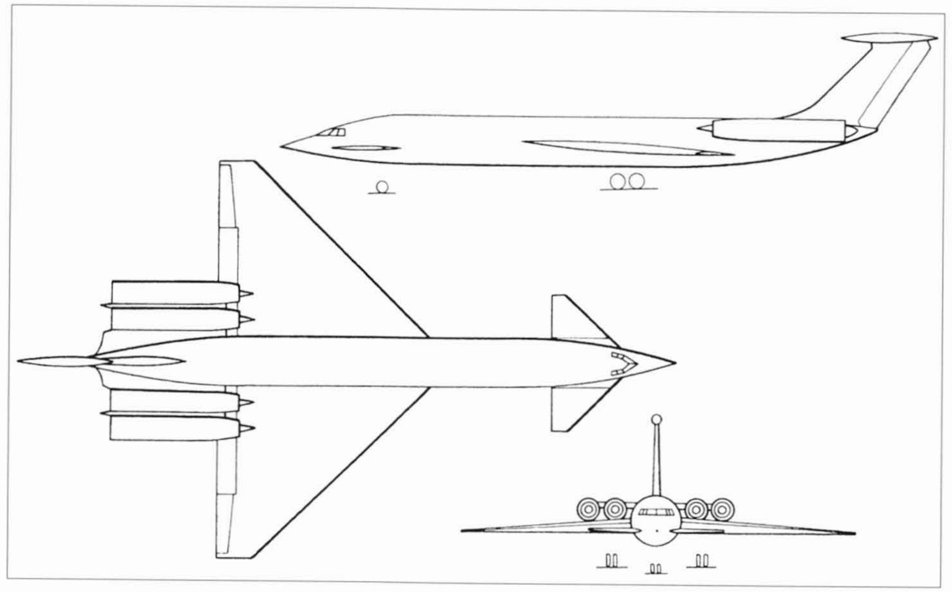
IL-64 airliner

In 1960 the Ilyushin OKB started design work on a 40- to 50-seat airliner which was allocated the designation IL-64. Initially, the 4,000-ehp NK-4A turboprop was considered as the powerplant for the new airliner. A derated version of the NK-4 could well be used on the IL-64, enabling the aircraft to carry 48 passengers over a distance of 1,800 km (1,119 miles) at a speed of 600 km/h (373 mph). Ilyushin signed a document containing a proposal for the IL-64 powered by two NK-4A engines on 3rd September 1960. Stressing the merits of the project, he expressed the opinion that it should be put into production right away; the first production machine, he argued, could be rolled out in June 1962. However, Ilyushin was not satisfied with the NK-4A's fuel efficiency. Moreover, the NK-4A had already been phased out of production and the similarly rated AI-20 turboprops were not available, being reserved entirely for the IL-18, An-10 and An-12 aircraft.

An alternative powerplant had to be sought. The second project version was to be powered four Izotov TV2-117S turboprops delivering 1,600 ehp apiece. The initial design studies of the revised project resembled a scaled-down 'second-generation' IL-18. Among the numerous problems that cropped up in the course of design work, there was the problem of ensuring the aircraft's controllability in a situation when an engine cut during the take-off run and a short runway left no choice but to continue the take-off. There were different ways of tackling the problem; one of them was to enlarge the vertical tail area. Alternatively, one could try to reduce the yaw created by the shutdown of an outboard engine. The OKB opted for the latter solution. The influence of asymmetric thrust would be diminished if the engines were placed closer to the fuselage axis. To achieve this, the OKB designers decided to arrange the engines in two packages, each of them comprising two engines placed in a common nacelle as close to the fuselage as possible. The coupled engines were to drive eight-bladed co-axial propellers via a common gearbox. (According to some sources, each engine drove its own four-bladed propeller independently, just as was the case on the British Fairey Gannet shipboard strike aircraft.)

With a TOW of 25 tonnes (55,125 lb), the IL-64 featured the same wing area as the IL-14. It was intended to carry 40 to 52 passengers over a distance of 500-1,600 km (310-994 miles). The fuselage had an oval cross-section, measuring 2.9 m (9 ft 6⅛ in) in width and 3.3 m (10 ft 10 in) in height. There were several seating arrangements, including an enhanced comfort version for 40 passengers, a version with first-class seating for 23 and a 16-seat executive version.

On 29th April 1961 Sergey V. Ilyushin presented this project for discussion at a meeting of the OKB's Technical council. However, this proposal did not find favour with the customer (the Ministry of Civil Aviation). A fresh approach had to be sought.



Ilyushin Aviation Complex

Above: A three-view of the projected IL-66 supersonic transport. Note the intake shock cones and the all-movable canards.

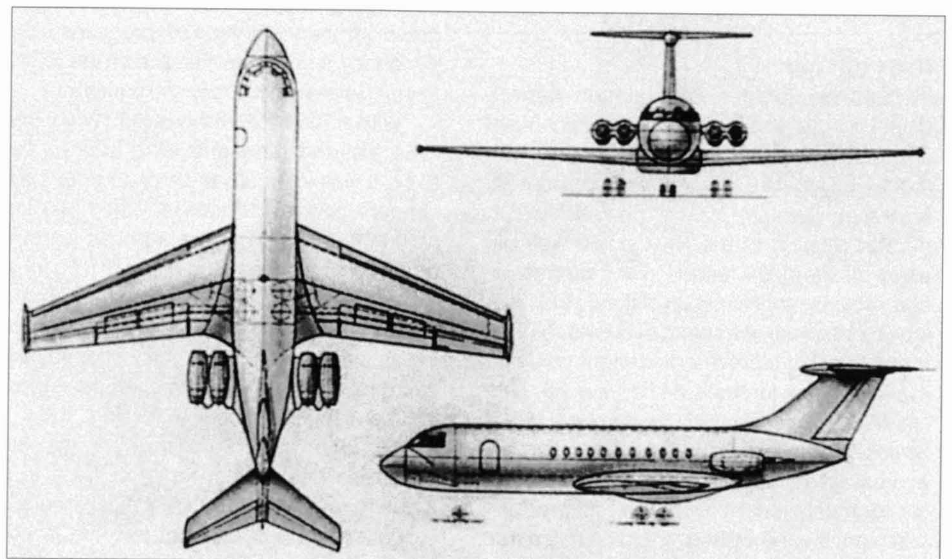
As an alternative, the OKB studied a version of the IL-64 with only two TV2-117S engines. With the available power halved, the seating capacity had to be reduced accordingly. The aircraft would carry only 25 passengers at an AUW of 13.5 tonnes (29,760 lb). However, this fell short of the stipulated targets. Eventually, the project was abandoned. (Some sources claim that the NK-4A-powered version was not the initial but the final version of the project; however, this does not tally with the dates cited above. Perhaps Ilyushin unsuccessfully tried to revive the initial project version?)

IL-66 supersonic airliner (first use of designation)

Preliminary studies on the feasibility of a supersonic transport (SST) were initiated in the Ilyushin OKB in 1959 at the initiative of its leader. Sergey V. Ilyushin proceeded from the assumption that his team could put to good use the experience accumulated in designing the P-20 supersonic cruise missile. The main specifications of the aircraft were determined by studies conducted in-house. The prospective SST was expected to carry 60-100 passengers to distances of up to 7,300 km (4,537 miles) at a cruising speed of 3,000 km/h (1,865 mph). The aircraft could be used on long-haul routes, such as the Moscow-Khabarovsk service. In the designers' opinion, putting a supersonic airliner into operation on that route would offer considerable time saving for passengers and would be economically viable.

The basic layout which emerged as a result of preliminary studies envisioned an aircraft of a canard configuration with delta wings and all-movable delta foreplanes. Four turbojets were to be mounted in pairs on the sides of the aft fuselage, IL-62 style; each engine had a movable intake centrebody (shock cone). Ilyushin expected the engines of the required thrust rating to be available: at that time the design bureaux led by Vladimir P. Klimov and Sergey K. Tumanskiy were engaged in developing afterburning turbojets (the VK-15B and the R15-300 respectively) which could prove suitable for the aircraft in question. The VK-15B had a take-off rating of 15,600 kgp (34,400 lbst), while the R15-300 was rated at 11,200-13,500 kgp (24,700-29,770 lbst).

In the spring of 1960 Ilyushin took some steps to obtain official consent to further work on the project. He addressed the Council of Ministers with a proposal that the project be included in the GKAT's prototype construction plan. However, the Committee's leaders took a justifiably sceptical view of the project which was obviously far too ambitious. Its implementation was clearly beyond the technological capabilities of the Soviet aircraft industry at that time. Ilyushin was advised to study the feasibility of an airliner with a lower supersonic speed, featuring an airframe made of the usual aluminium alloys (the IL-66 project was based on the use of heat-resistant steel alloys). Appropriate studies undertaken by the OKB resulted in a completely new project (see IL-72).



Ilyushin Aviation Complex

'When I grow up, I will be an IL-62.' The similarity of the projected IL-70 to the bigger IL-62 is obvious.

IL-66 military transport aircraft (second use of the designation)

In the early 1960s, when the Kuznetsov NK-8 turbofan rated initially at 9,500 kgp (20.940 lbst) for take-off became available, several design bureaux undertook studies of military transport aircraft projects based on the use of these engines. One of these was the Ilyushin OKB which came up with an advanced development project of the IL-66 transport powered by four podded NK-8s under the wings. (this project had nothing in common with the supersonic airliner of the same name). The new military transport was to have an AUW of nearly 140 tonnes (308,700 lb). However, this project, too, progressed no farther than the drawing board.

IL-70 short-haul airliner (first use of designation)

A project bearing this designation was studied in the Ilyushin OKB in response to a requirement for an airliner intended for local domestic services. The aircraft was expected to carry 24 passengers over distances of 1,000-1,900 km (621-1,180 miles) at a cruising speed of 700 km/h (435 mph). The project envisaged a machine featuring low-set wings swept back 20° at quarter-chord, a T-tail and four turbojet engines mounted on the rear fuselage; the aircraft looked like a baby IL-62. The use of four engines for so small an aircraft was due to a decision to make use of the Tumanskiy R19M-300 turbojet with a modest thrust rating of 1,150 kgp (2,540 lbst).

Much attention was given to ensuring the aircraft's ability to operate from unpaved airfields; this explains the four-wheel main undercarriage units that can be seen on a general arrangement drawing of the aircraft. At an AUW of 14.6-17 tonnes (32,190-37,485 lb) the IL-70 was expected to have a take-off run of 520-830 m (1,710-2,720 ft). Preliminary design studies resulted in a so-called technical proposal which was sent to the State Committee for Aviation Hardware and to the Main Directorate of Civil Aviation on 23rd November 1961. If approved, the aircraft could enter manufacturer's flight test in the last quarter of 1964. The proposal was duly considered, but the IL-70 lost to a rival design – the trijet Yak-40.

IL-70 short-haul airliner (first use of designation)

There was also a project of an airliner bearing the same designation (IL-70) but powered by four 1,500-kgp (3,310-lbst) Ivchenko AI-25 turbofans. The project failed to receive the go-ahead because the An-24 twin-turboprop airliner with roughly the same seating capacity (up to 52) had just entered scheduled services and there was no urgency in creating a similar machine.

IL-70 airborne early warning aircraft (third use of designation)

Little is known about this project dating back to 1969. The Ilyushin OKB conducted initial design studies on the project of an AEW aircraft which were submitted to the VPK (the Defence Industry Commission of the CofM Presidium). On 9th July 1969 the Commission adopted a decision calling for further work on the basis of these design studies. However, there are no indications that the project was proceeded with; the work must have been discontinued at an early stage.

IL-72 supersonic airliner (first use of designation)

The original IL-66 SST project was completely reworked and accordingly allocated a new designation, IL-72. Its design specifications were more realistic – the seating capacity was reduced to 40-60 passengers, the cruising speed target was Mach 2.2. The lower speed made it possible to choose aluminium alloys as the main structural materials. The range was expected to be 4,000-4,500 km (2,486 to 2,797 miles).

On 14th February 1961 these design targets were discussed at the OKB's Technical council. However, the OKB was unable to proceed with this project, its resources being overtaxed by work on the IL-18's versions and the IL-38 ASW aircraft and by the construction of the IL-62 prototype. No information is available on the layout and external appearance of the airliner in its revised configuration.

Robert Ruffle

Above: A display model of the IL-74 trijet medium-haul airliner.The main gear bogies were to retract into fairings at the wing roots.

Ilyushin Aviation Complex

An artist's impression of the IL-74. The fairing above the centre engine's nozzle gave the aircraft a striking similarity to the Hawker Siddeley Trident 1/Trident 2.

IL-72 medium-haul airliner (second use of designation)

In 1964 the Ilyushin OKB initiated design work on projects of airliners intended to supersede the Tu-104, IL-18 and An-10 airliners in due course. One of these projects was the IL-72 airliner. In its basic layout it had much in common with the IL-62 which was under test at that time. The IL-72 featured swept wings, a T-tail and four engines mounted on the rear fuselage.

The design specifications envisaged a 150-seat capacity and a payload of 18 tonnes (39,690 lb), a range of 3,500 km (2,175 miles) and a cruising speed equivalent to Mach 0.82-0.85. The aircraft was intended to operate from 2,000-m (6,560-ft) runways and was provided with appropriate high-lift devices which included triple-slotted Fowler flaps.

Detailed analysis of the adopted layout revealed that the four-engined configuration was not a rational option in this case (as distinct from the bigger IL-62); it entailed excessive maintenance costs reducing the aircraft's profitability. As a result, the work on this project was discontinued in 1965.

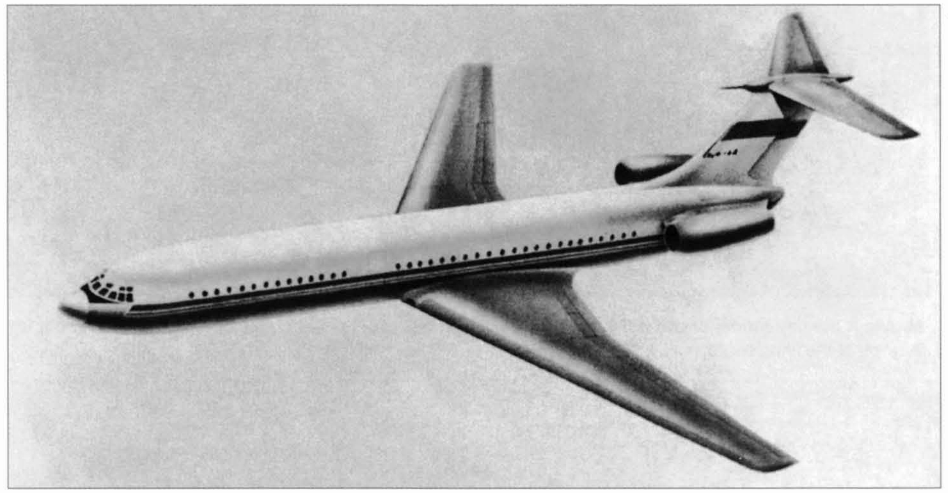
IL-74 medium-haul airliner

This project made its appearance in 1966. It was a 144-seat medium-haul airliner powered by three Solov'yov D-30I turbofans delivering 6,800 kgp (14,990 lbst) for take-off. The design specifications included a practical range of 3,900 km (2,424 miles) in the 144-seat version with a 81-tonne (178,570-lb) maximum TOW; in the 120-seat version the range was increased to 4,600 km (2,859 miles). The aircraft was to have a cruising speed of 900 km/h (559 mph). The airliner's wing were fitted with slats and triple-slotted Fowler flaps enabling it to operate from 2,000-m (6,560-ft) runways.

The aircraft closely resembled the Tu-154 which was under development at the time. The main external difference was the absence of the wing-mounted main gear fairings characteristic of the Tu-154 (on the IL-74 the main gear bogies retracted into the wing roots). The design specifications of the two aircraft were subjected to comparative studies at the Ministry of Aircraft Industry. Eventually MAP opted for the Tu-154 because this machine promised a higher cruising speed and a lower take-off weight.

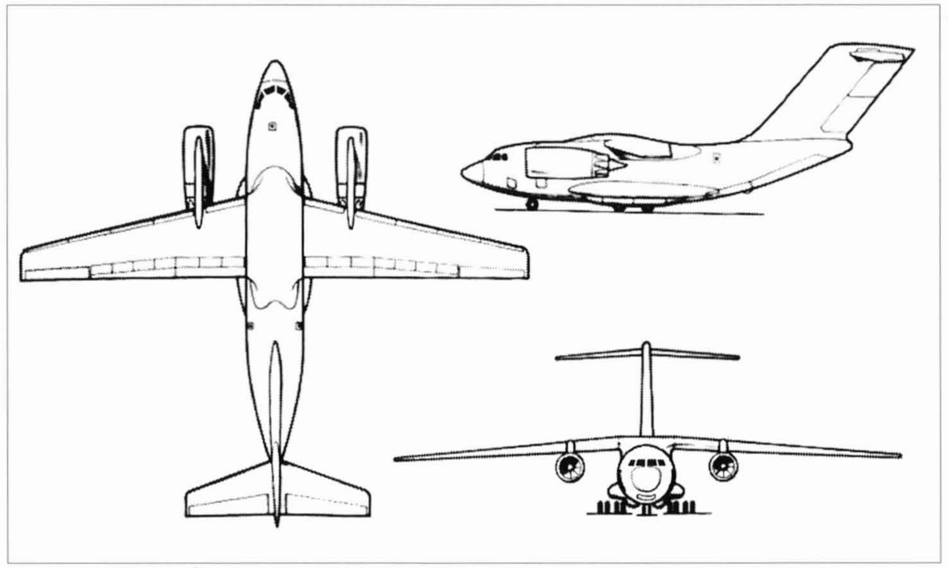
IL-82 short-haul airliner (first use of designation)

In 1968 the Ilyushin OKB started design work on the IL-82 airliner which was intended to supersede the Tu-134 on short-haul



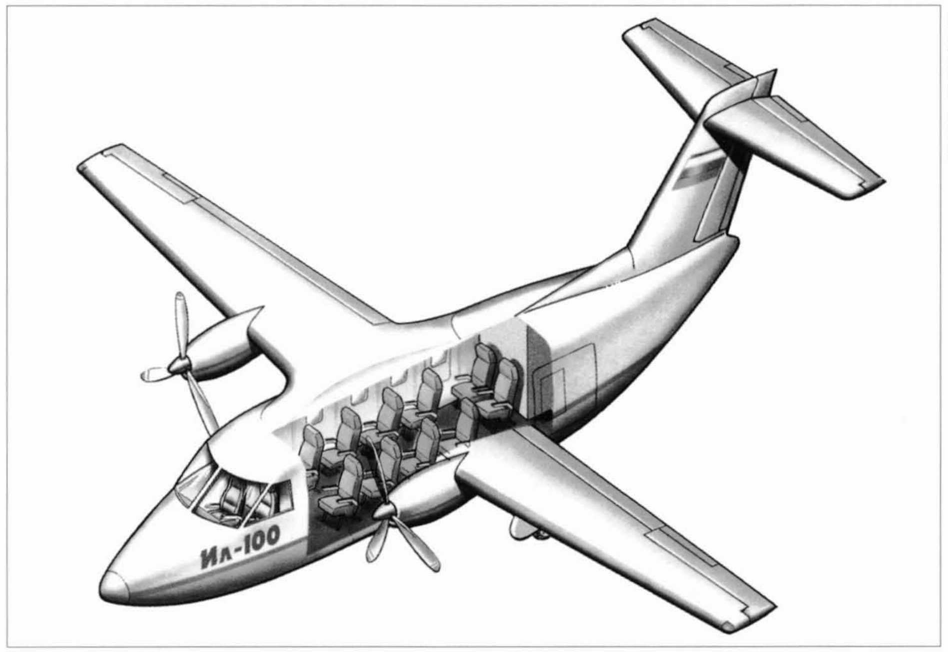
Ilyushin Aviation Complex

Above: An artist's impression of the IL-82 airliner. The fuselage nose treatment was yet another iteration of the IL-62.



Ilyushin Aviation Complex

Above: A three-view drawing of the NK-56 powered version of the IL-88. The aircraft looked like a cross-breed between the IL-76, the Boeing YC-14 and the McDonnell Douglas YC-15.



Ilyushin Aviation Complex

An artist's impression of the IL-100 feederliner.

routes. The aircraft was intended to carry 120 passengers to distances of 1,500-2,000 km (932-1,243 miles) and operate from 1,800-m (5,906-ft) runways. The cruising speed was to be 850-860 km/h (528-534 mph). Again, the aircraft resembled the Tu-134 in basic configuration, apart from the wing-mounted main gear fairings and the glazed navigator's station and chin radome. The IL-82 featured moderately swept wings, a T-tail and two Solov'yov D-30M-1 turbofans with a take-off thrust of 9,500 kg (20,947 lb) mounted on the rear fuselage.

A technical proposal on the IL-82 was submitted to MAP and MGA in December 1968. However, the authorities decided that the time was not yet ripe to replace the Tu-134 which was rendering good service on Aeroflot's routes. The work on the IL-82 was terminated. The designation was later re-used for an airborne command post derivative of the IL-76 (see Chapter 4).

IL-88 tactical transport aircraft

Pursuant to an order issued by MAP in June 1972, the Ilyushin OKB started design work on this medium military transport aircraft intended to supersede the An-12. It was a high-wing monoplane with a T-tail and wings possessing a moderate sweepback on the leading edges. Its design characteristics included a range of 3,000 km (1,865 miles) with a payload of 30 tonnes (66,150 lb). The OKB submitted for consideration two advanced development projects featuring different powerplants. In one version the aircraft was to be powered by four 11,000-ehp Lotarev D-236 propfan engines driving SV-36 contraprops with eight blades in the front row and six in the rear row; in the other version the powerplant comprised two 18,000-kgp (39,680-lbst) Kuznetsov NK-56 turbofans. The latter powerplant was less fuel-efficient but could be commended on account of maintenance simplicity and the greater speed that it would afford. However, the Air Force opted for the propfan-powered version. In a subsequent contest the IL-88 lost to the other contender, the An-70 which eventually emerged as a machine in a heavier class than the An-12.

IL-90 long-haul airliner

This was an airliner intended to supersede the IL-62. The work on the IL-90 was conducted concurrently with the development of the IL-96-300. The IL-90 was to have a payload of 20 tonnes (44,100 lb) and a range of 9,000 km (5,594 miles) at a cruising speed of 850 km/h (528 mph).

Preliminary studies included various layouts featuring both a widebody and a narrow-body fuselage, a twin-engine and a three-engine configuration. For example, in December 1979 the OKB put forward a proposal for an IL-90 version seating 220 passengers and powered by two NK-86 turbofans. A later proposal (1989) envisaged the IL-90-200 powered by two 18,000-kgp (39,680-lbst) NK-92 contra-rotating integrated shrouded propfan (CRISP) engines and intended to carry 200 passengers. Eventually the OKB opted for a variant powered by two identically rated NK-93 CRISP engines on underwing pylons. In the course of projecting the OKB decided to increase the IL-90's range to 10,000-11,000 km (6,215-6,837 miles) with a 20-tonne payload and 12,000-13,000 km (7,458-8,080 miles) with a 15-tonne (33,075-lb) payload.

The project was endorsed by the General Designer in December 1988. However, the economic situation of the early 1990s, with the country in the throes of a crisis, prevented the project from being implemented.

IL-100 light multi-purpose aircraft

The Ilyushin OKB has been doing design work on this project since the late 1990s. This is a fairly small multi-purpose aircraft intended to fill the niche now occupied by the venerable An-2 biplane and, to some extent, by the Let L-410. The An-2 has proved amenable to a multitude of roles; the same is expected of the new machine. The baseline version will include two sub-variants intended respectively for passenger and cargo transportation. In the passenger version it can carry 12 passengers.

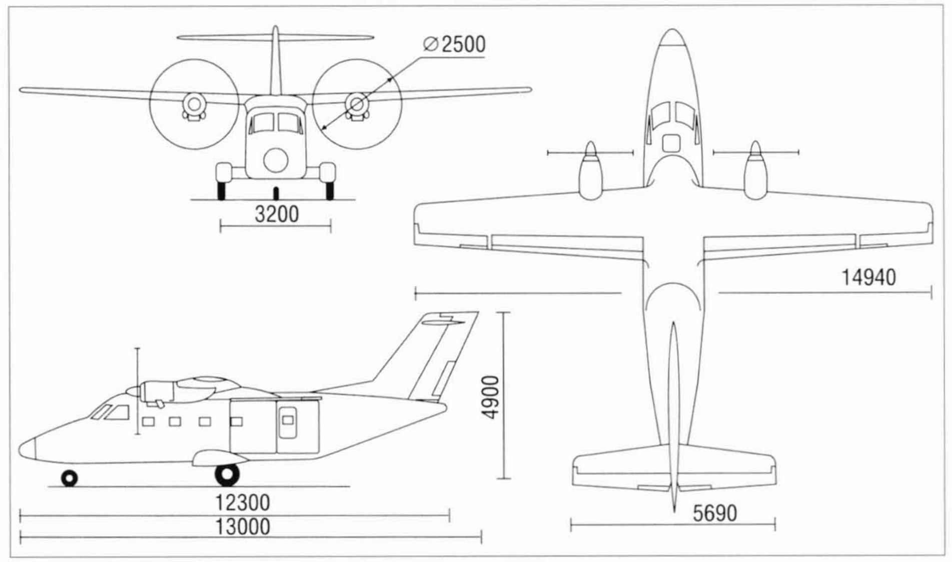
The IL-100 is a cantilever high-wing monoplane with a retractable nosewheel undercarriage. It is powered by two Kuznetsov NK-123VR turboprops rated at 550 ehp for take-off and driving three-bladed propellers. Export versions may be powered by Western engines, including the well-known Pratt & Whitney Canada PT-6A. With a payload of 1,000 kg (2,205 lb) the IL-100 will be able to cover the distance of some 1,000 km (620 miles) at a cruising speed of 400 km/h (249 mph). The OKB seeks to combine in the IL-100 the best features of the An-2 –sturdiness, reliability, good short-field performance – with greatly improved fuel efficiency, enhanced passenger comfort and modern equipment.

Two baseline versions are envisaged which will serve as a starting point for further variants. These include:

- the IL-100M – a stretched version with 'plugs' inserted fore and aft of the wings to accommodate 16-18 passengers;

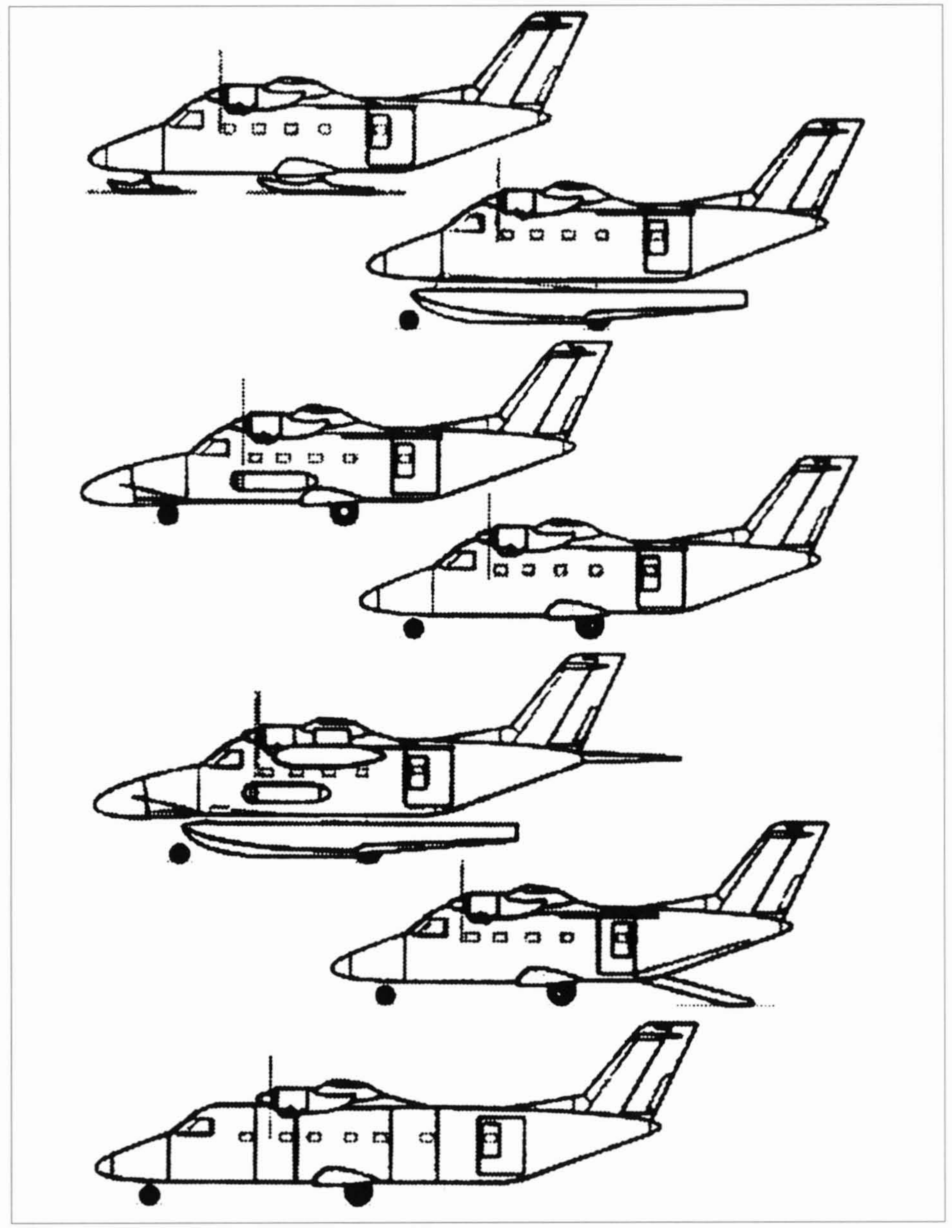
- the IL-100A – a stretched version with 18-20 seats.

- the IL-100T (***trahns**portnyy*) assault transport version intended to carry 14 troops with their small arms and fitted with a cargo ramp in the aft fuselage;



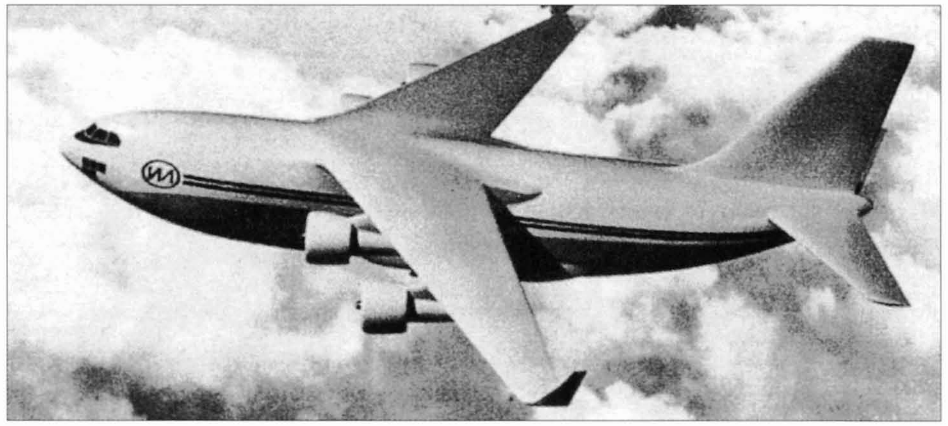
Ilyushin Aviation Complex

Above: A three-view drawing of the IL-100. Note the large sliding door incorporating an emergency exit.



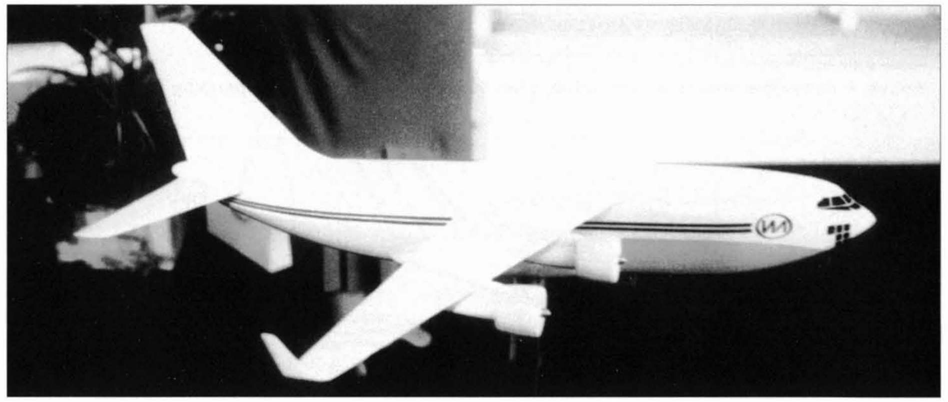
Ilyushin Aviation Complex

Top to bottom: the IL-100 on skis, the IL-100V, the border patrol version, the baseline version, the amphibious ASW version with an MAD and auxiliary tanks, the IL-100T military transport and the IL-100M.

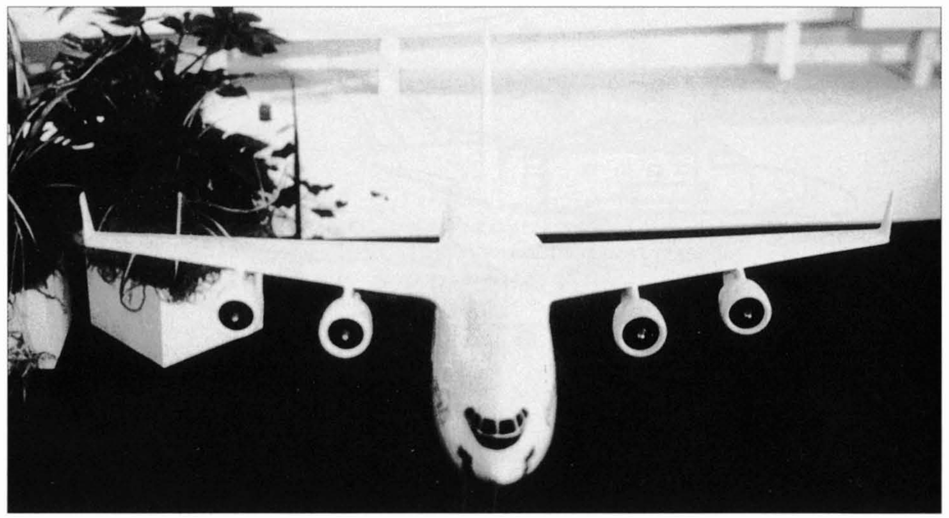


Ilyushin Aviation Complex

Above: An artist's impression of the IL-106. Note that the flightdeck section is borrowed from the IL-96. The vicious scowl of the navigator's station glazing and the overall proportions give the aircraft a brutish look.



Sergey Komissarov



Sergey Komissarov

Centre and above: This model of the IL-106 was displayed at the MosAeroShow-92.

Specifications of the IL-112 (estimated performance)

Type	IL-112 airliner	IL-112V
Engine type	TV7-117S	TV7-117S
Take-off power, ehp	2 x 2,466	2 x 2,466
Wing span	22.55m (73 ft 11¾ in)	23.45m (76 ft 11¼ in)
Length	21.78m (71 ft 5½ in)	20.65m (67 ft 9 in)
Max TOW, kg (lb)	14,530 (32,033)	16,700 (36,817)
Max payload, kg (lb)	4,000 kg (8,818 lb)	6,000 (13,227 lb)
Cruising speed at 7,600 m (24,950 ft), km/h (mph)	550-600 (342-373)	650 (404)
Range, km (miles)	1,500 (932)	1,000 (621) with 6,000 kg payload

- the IL-100SKh (***sel'skokhoziaystven**nyy*) agricultural version for crop-dusting and other uses;
- the IL-100V (***vod**nyy* – water-borne) amphibious version with the wheels retracting into the twin floats;
- a ski-equipped version for Polar areas;
- a radar-equipped patrol version;
- an amphibious maritime patrol aircraft for operations in coastal areas;
- an aerial photography version, etc.

It should be noted that the IL-100 owed its inception to a request for a special aircraft which came from the Russian Federal Border Guards (FPS – *Fede**rahl'**naya pogra**nich**naya **sloozh**ba*). Later, however, the new chief of the FPS backed out of the project, and the prospects of funding became uncertain, which may seriously delay implementation of the project.

IL-106 heavy military transport

This heavy transport aircraft was under development in the Ilyushin OKB in early 1990s. It was presented to the general public in 1992 when a model of this aircraft was exhibited at the MosAeroShow-92 in Zhukovskiy. The aircraft featured shoulder-mounted swept wings with winglets and a conventional tail unit with a low-set horizontal tail. The powerplant comprised four underslung NK-92 CRISP engines delivering 18,000 kgp (39,690 lbst) apiece. The aircraft was expected to carry a payload of 80 tonnes (176,400 lb) over a distance of 5,000 km (3,108 miles) at a cruising speed of 820 to 850 km/h (519 to 528 mph). Its cargo hold was 6 m wide, 4.6 m high and 34 m long (19 ft 8¼ in, 15 ft 1 in and 111 ft 6½ in respectively). The maximum all-up weight was 258 tonnes (568,890 lb). The fuselage featured a rear loading ramp for cargo handling and paradropping. A version with a forward-fuselage cargo hatch was also considered. The aircraft was intended for operation from both paved and unpaved runways. Lack of funding caused by the political turmoil and economic problems prevented this project from progressing to the hardware stage. In the meantime, the NK-92 engine appears to have been abandoned in favour of its derivative – the NK-93 with the same thrust rating and improved fuel efficiency. The IL-106 project still retains its value and might well be revived, given the customer's interest.

IL-108 executive aircraft

The designation IL-108 covers several executive aircraft projects developed in the Ilyushin OKB since 1988. The first such project envisaged an aircraft with 9 to 15 seats and a range of no less than 5,000 km (3,107 miles) at a cruising speed of 850 km/h (528 mph). It was a low-wing monoplane with moderately swept wings and a T-tail; two Lotarev DV-2 turbofans rated at 2,200 kgp (4,850 lbst) for take-off were mounted on the rear fuselage. The nine-seat layout would be used for the executive version, while the 15-seat configuration was intended for scheduled services on low-density routes.

As advertised in 1990, this project had the following specifications: all-up weight14,300 kg (31,530 lb); payload 1,500 kg (3,310 lb); range with maximum payload 4,500 km (2,797 miles); range with a maximum number of passengers (15) 4,850 km (3,014 miles); cruising speed 800 km/h (497 mph); wing span 15 m (49 ft 2½ in). The aircraft was to be provided with satellite communications equipment and an autonomous navigation system.

Another version of the IL-108 was to have a range 7,600 km (4,723 miles) enabling it to fly non-stop from Moscow to New-York at a cruising speed of 950 km/h (580 mph). In different layouts it provided accommodation for 6 to 19 passengers with a high degree of comfort. The use of both Russian and Western engines was envisaged.

To attain these ambitious performance characteristics, a comprehensive series of studies and experiments was needed, along with the use of new, more fuel-efficient engines, state-of-the-art avionics and so on. The range of problems to be tackled would have stretched the OKB's resources too far at the beginning of the 1990s, and the projects had to be shelved.

Ilyushin Aviation Complex

Above: Biz-jets tend to be all alike. Yet, while resembling the Canadair Challenger, the plump little IL-108 has a character of its own, with a nose revealing Ilyushin lineage and characteristically high-set engines.

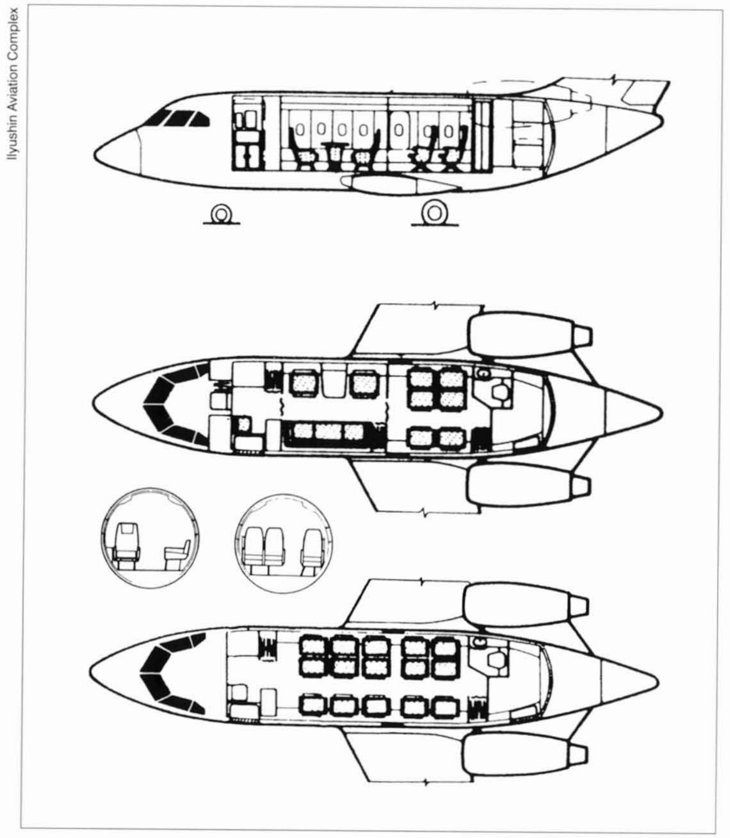
IL-112 multi-purpose transport

Design work on this high-wing twin-turboprop transport started in 1994. It was projected simultaneously in several versions, including a 40-seat passenger aircraft. This is a conventional high-wing monoplane with constant-chord inner wings, tapered outer wing panels and a T-tail with a sweptback fin and rudder; the circular-section fuselage is pressurised. The IL-112 has a retractable tricycle landing gear, the main units retracting into fuselage sponsons, and is powered by two Klimov TV7-117S turboprops driving Aerosila SV-34 six-bladed propellers.

An executive version differs from the airline passenger model in having the cabin divided into three sections, one of which was intended for the main passenger and the other two accommodated in all 15 passengers in enhanced comfort conditions.

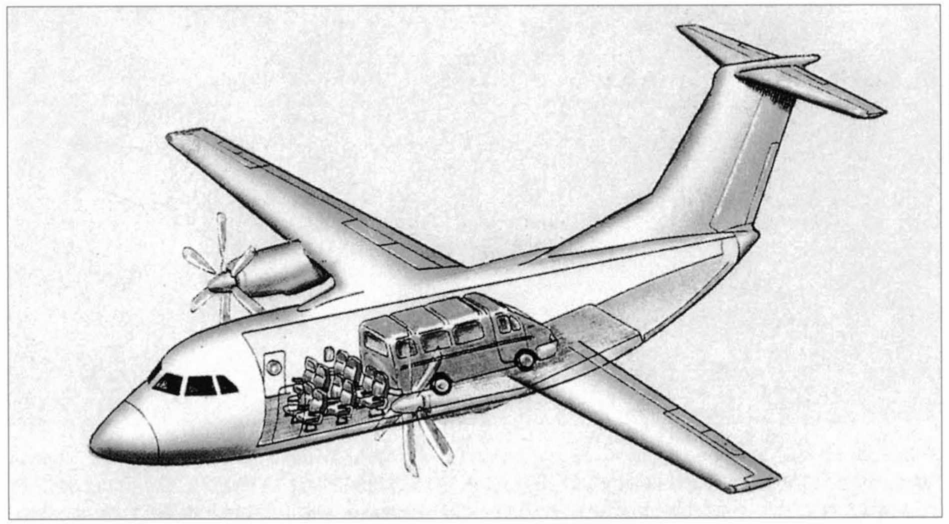
The IL-112T is a freighter version with rear loading ramp.

Ilyushin Aviation Complex



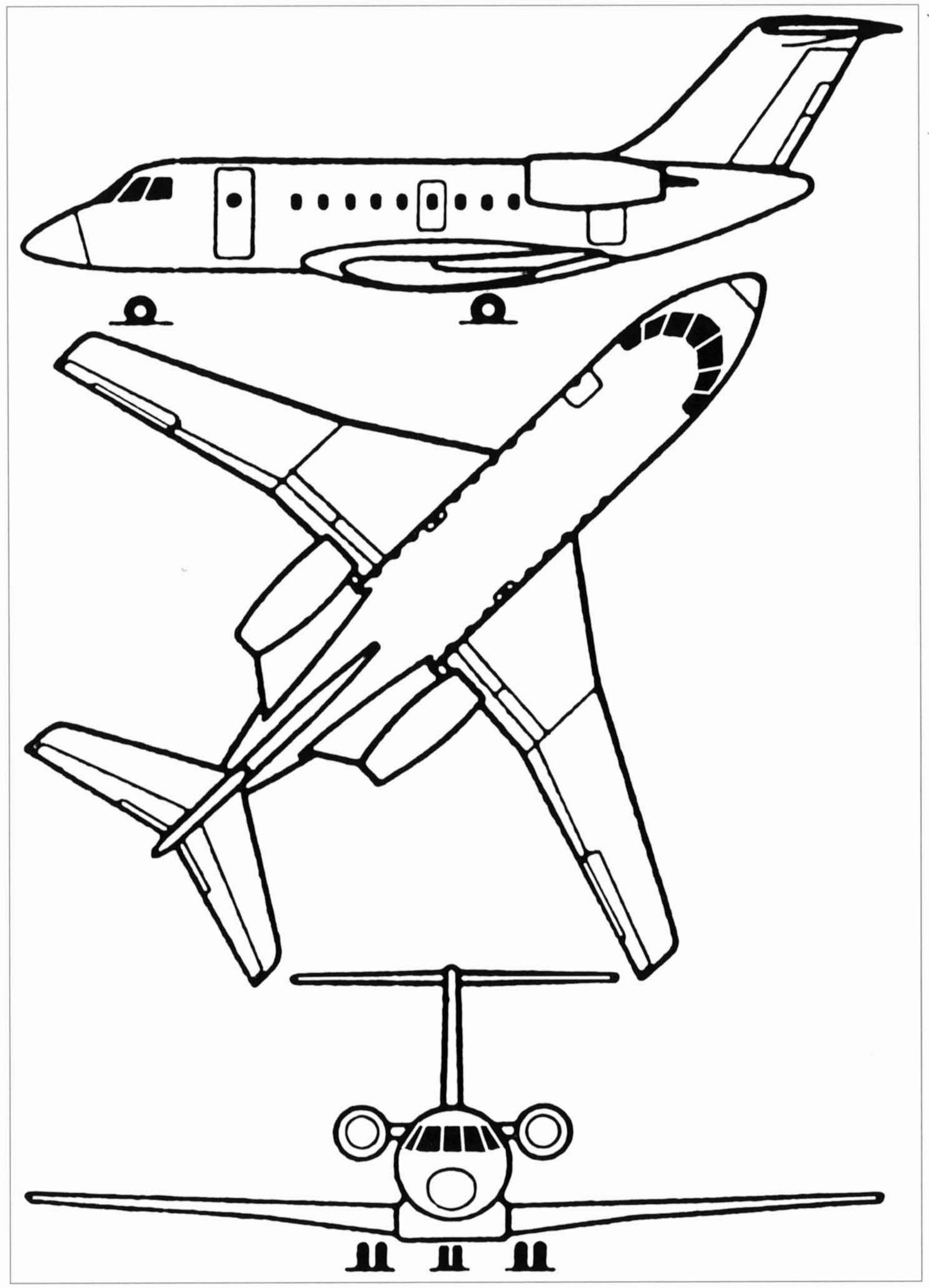
Ilyushin Aviation Complex

Left: A three-view drawing of the IL-108.
Above: Two possible interior layouts of the IL-108 – the 11-seat executive version and the 15-seat airliner version.



Ilyushin Aviation Complex

Left: a cutaway drawing of the IL-112T.



Ilyushin Aviation Complex

The IL-126 business jet.

IL-112V tactical military transport

The IL-112V (*voyennyy* – military) light multi-purpose transport is intended to supersede the venerable Antonov An-26 tactical transport, with which it is in the same class, for both military and civilian needs. It is a derivative of the IL-112 airliner described above.

The IL-112V shares the An-26's high-wing twin-engined layout and rear cargo door permitting paradropping, but differs in having a T-tail. The powerplant comprises two TV7-117S Series 2 turboprops which will make the new aircraft considerably superior to the An-26 in fuel efficiency. The IL-112V is expected to attain a speed of 550-600 km/h (342-373 mph) and to be capable of operating from short airstrips not exceeding 1,000 m (3,280 ft). In overload configuration the IL-112V will be able to carry an 8-tonne (17,640-lb) payload over a distance of 1,000 km (620 miles). The normal payload is 6 tons (13,230 lb) and the maximum range is 6,000 km (3,730 miles).

The IL-112V project was submitted for a contest arranged by the Ministry of Defence in which it was up against the MiG-110 and the Sukhoi S-80 (Su-80). In 1999 there were reports claiming that the IL-112V emerged as the winner, but they were apparently wishful thinking. As late as 2001 the contest was still going on, and the ultimate fate of the IL-112V project is still uncertain.

There were reports that the Ilyushin OKB was studying an ASW derivative of the IL-112 intended to supersede the IL-38 (along with similar projects based on the IL-114).

IL-126 executive aircraft

This business jet project was developed primarily for the domestic market and was based on the use of available technologies and hardware. This was a low-wing monoplane with a T-tail and aft-mounted engines. It was to carry five to ten passengers over a distance of 4,000 km (2,486 miles) at a cruising speed of 730 km/h (453 mph). The powerplant comprised two Ivchenko AI-25TL turbofans with a take-off thrust of 1,720 kgp (3,790 lbst). The project seemed to hold promise, attracting much interest on the part of prospective customers in Russia, but the ever-present funding difficulties prevented it from progressing to the hardware stage.

IL-PS multi-purpose aircraft

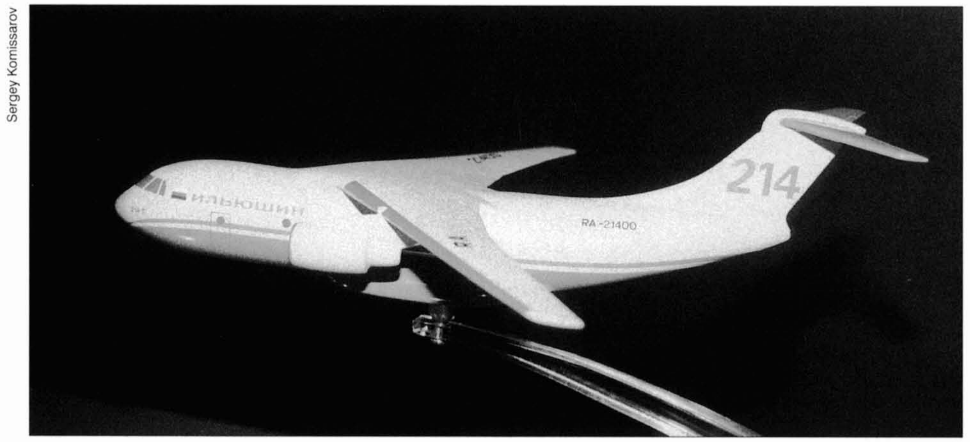
This aircraft is intended for carrying up to 12 passengers or cargoes weighing up to 1,500 kg (3,310 lb) over distances of up to 1,500 km (932 miles). Emphasis is placed on attaining considerably higher fuel efficiency and meeting the most stringent requirements with regard to noise levels and so on.

IL-X (Ilyushin X) executive aircraft and commuter airliner

Information about this project based on the OKB's advertising materials was published in 1990. This small passenger aircraft measuring 18.0 m (59 ft ⅝ in) in wing span and 16.30 m (53 ft 6 in) in length was projected in an executive version for seven or eight passengers and in a commuter version for 19 passengers. The aircraft featured moderately swept low-set wings and a T-tail. Two 1,500-ehp Novikov TVD-1500 turboprops were pylon-mounted on the rear fuselage, driving four-bladed contra-rotating pusher propellers, making the aircraft very similar to the Embraer Vector. Estimated performance included a maximum payload of 2,100 kg (4,630 lb), a maximum cruising speed of 620 km/h (385 mph), an economical cruising speed of 575 km/h (357 mph) and a maximum range of 4,000 km (2,486 miles) with seven passengers and two crew. This project must have been abandoned by now.

IL-XXX airliner

Little is known about this airliner project, apart from a brief mention in the Russian aeronautical press where it was stated that this was a 'prospective fifth-generation civil aircraft'. Together with the Beriyev Be-200, Ilyushin IL-214 and Tupolev Tu-334, it was

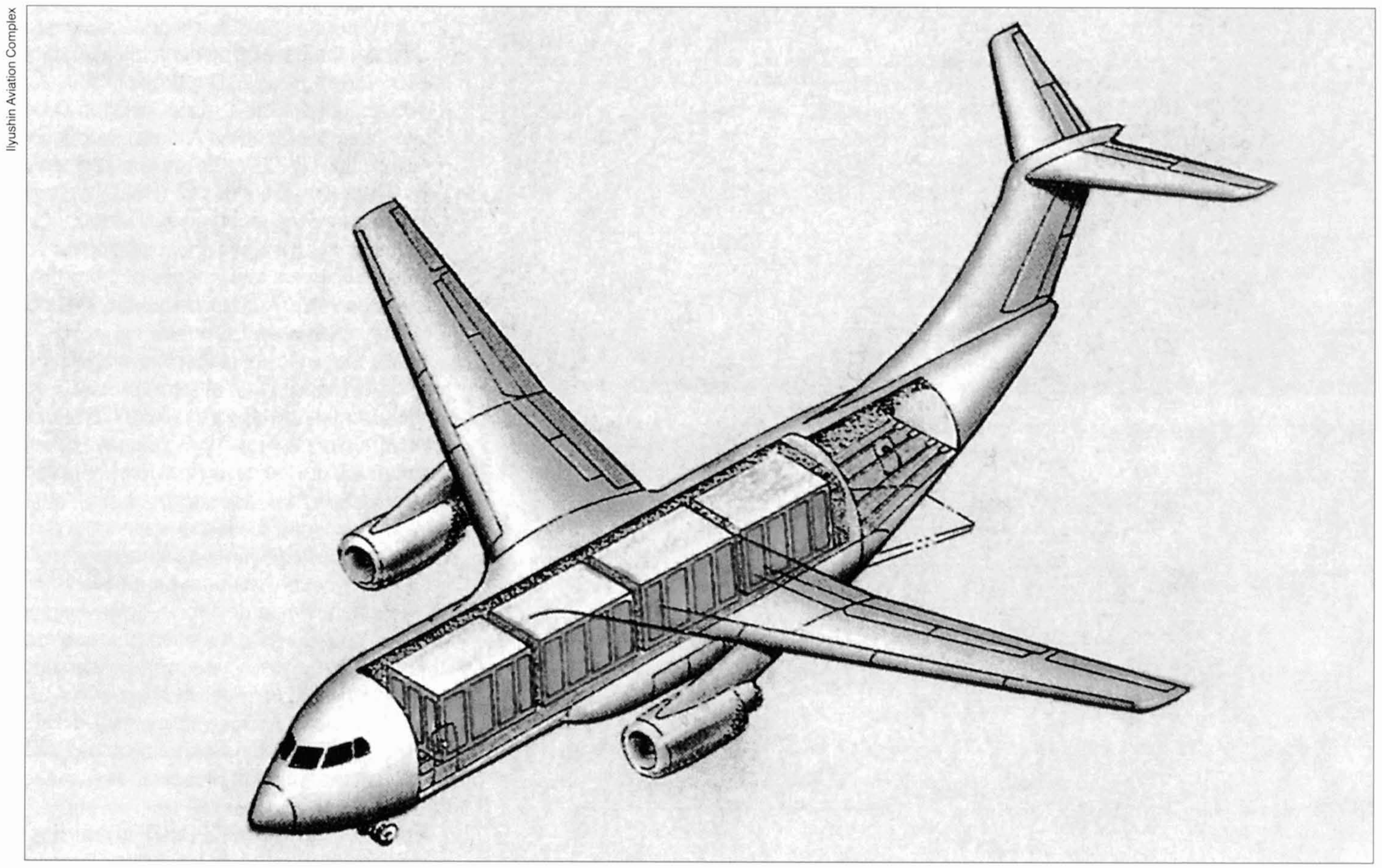


Sergey Komissarov

Above: A model of the IL-214T commercial transport exhibited at the MAKS-2001 airshow.

Below: This model of the IL-214 shown at the MAKS-2003 is marked IRTA (Indian-Russian Transport Aircraft).

Dmitriy Komissarov



Ilyushin Aviation Complex

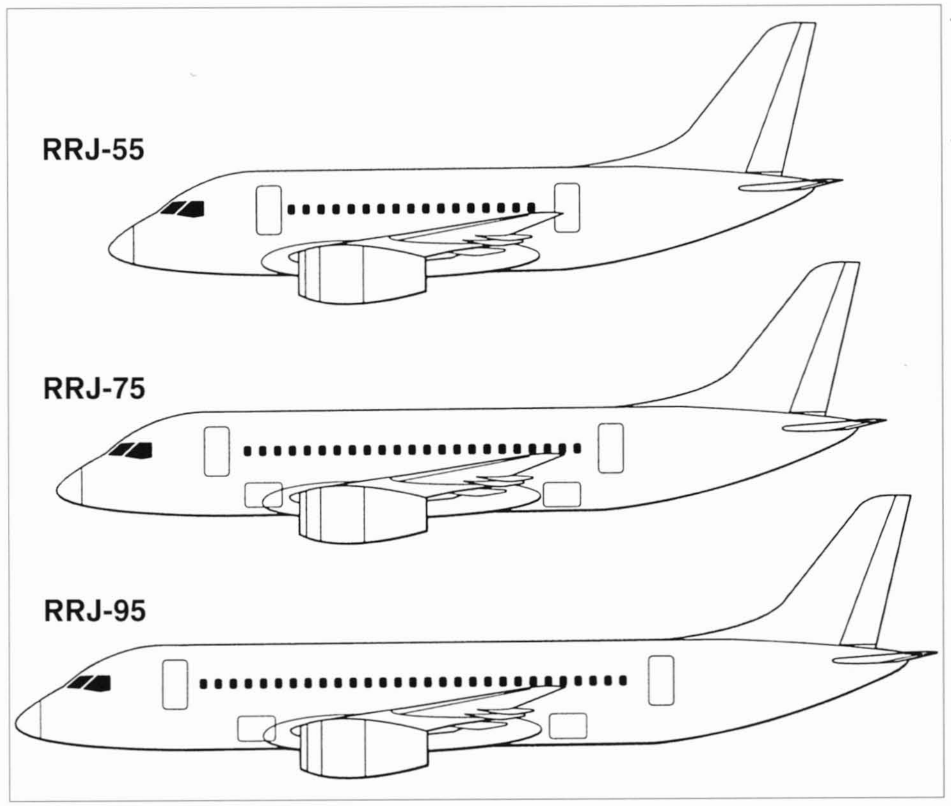
A cutaway drawing of the IL-214, illustrating its possible commercial use with four cargo containers in the cabin.


Dmitriy Komissarov

Above: This model of the RRJ-55 was displayed at the Civil Aviation-2002 airshow in Moscow in August 2002.

Ilyushin Aviation Complex

Above: This artist's impression of the RRJ-75 shows a different shape of the engine nacelles, the core and bypass flows being mixed inside the nacelle. Note also the increased flightdeck glazing area.



Ilyushin Aviation Complex

This diagram illustrates the relative size of the aircraft in the RRJ family. The smallest RRJ-55 has no underfloor baggage compartments.

among the aircraft types expected eventually to be powered by the new Aviadvigatel' PS-9 turbofans in the 9,000-10,000 kgp (19,840-22,040 lbst) thrust class that were under development in 2000.

IL-214 (MTA, IRTA) transport aircraft

This project currently under development has inherited many features of the stillborn IL-88, albeit it is a smaller aircraft in the 20-tonne (44,100-lb) payload class. As was the case with the IL-88, the IL-214 is expected to provide a replacement for the An-12. The aircraft has shoulder-mounted swept wings and a T-tail; it is powered by two PS-9 turbofans in underwing nacelles, with provisions for installing Pratt & Whitney PW6000 turbofans for export. Operational requirements stipulate the carriage of a 20-tonne payload over a distance of 2,500 km (1,554 miles). The dimensions of the cargo hold are chosen with a view to meeting both military airlift requirements and commercial cargo transportation needs (the commercial version is designated IL-214T for ***trahnsport**nyy*). Provision is made for paradropping troops and cargoes.

The IL-214 project was chosen as the basis for a joint Russian-Indian programme called Multi-purpose Transport Aircraft (MTA) – presumably as a replacement for the Antonov An-32. An appropriate agreement was signed by Russia and India; it provides for the development of this aircraft on a risk-sharing basis. The project's Russian participants are the Ilyushin Aviation Complex and the Irkutsk Aircraft Production Association (IAPO); the Indian partner is Hindustan Aeronautics Ltd. (HAL). For India this agreement is of special importance because it envisages the participation of Indian designers at all stages of the project and thus will ensure invaluable experience for the Indian aircraft industry.

A model of the prospective joint-venture aircraft demonstrated at the MAKS-2003 airshow carried the legend IRTA (Indian-Russian Transport Aircraft). This may be an alarming sign, indicating that Russia is gradually backing out of the programme.

Interestingly, the IL-214 appears to have been conceived initially as a passenger aircraft; according to a report published in 1998, there was a design study envisaging the IL-214-100 regional airliner capable of carrying 100 passengers over a distance of 3,500 km (2,173 miles) at a speed of 870 km/h (540 mph). This version may eventually be revived if development of the baseline transport aircraft proceeds as planned.

Russian Regional Jet (RRJ) airliner

In June 2001 the Ilyushin Aviation Complex, the Sukhoi Civil Aircraft company and the Boeing Commercial Aircraft Group (BCAG) signed a Memorandum of Understanding concerning the joint programme of creating a family of Russian Regional Jet (RRJ) airliners. Later these partners (Sukhoi being the prime contractor on the Russian side) were joined by the Yakovlev OKB.

The RRJ family comprises six models differing in range (normal/long range) and seating capacity (55, 75 and 95 seats). All aircraft in the family share the same wings and have a very high degree of commonality as regards the airframe, engines and equipment. In March 2003 the final choice of the powerplant was made – it is the SM-146 turbofan developed jointly by Lyul'ka-Saturn and SNECMA. The engine, which will have a thrust rating of 6,130-8,000 kgp (13,520-17,640 lbst), will power all the versions (standard and long-range variants). The first prototype RRJ is to enter flight test in early 2006. Manufacture is scheduled to take place at the plants in Novosibirsk and Komsomol'sk-on-Amur. In early March 2003 the RRJ won the Russian state tender for a regional airliner, beating the Tu-414 and the Myasishchev M-60-70.

The 75-seat RRJ-75 will be the baseline version. A short-fuselage version seating 55 and designated RRJ-55 will be produced by taking out fuselage sections fore and aft of the wings. Conversely, the RRJ-95 with a 95-seat passenger cabin will be obtained by inserting 'plugs' fore and aft of the wings.

From the outset the project was aimed at international certification which will ensure a wide market for these airliners. Production of the RRJ family is expected to be around 600 aircraft; half of this amount will be sold in the CIS, while the rest is to be offered on the international market.

MS-21 short-/medium-haul airliner

This is another joint project in which the Ilyushin Aviation Complex is participating at present. Ilyushin is joining forces with the Yakovlev Design Bureau to design and manufacture a family of short- and medium-haul airliners that will meet the requirements of the Federal programme of the development of civil aviation in Russia. The project will be implemented with the participation of IAPO and the Ilyushin Finance Co. as a leasing company.

The MS-21 family of airliners is based on the Yak-242 project which had been developed several years ago but failed to get the go-ahead for financial reasons. The designation is deciphered as *maghis**trahl**'nyy samo**lyot** dva**dtsat' **per**vovo** **veka*** – 21st Century airliner, no more, no less! In 2003 the MS-21 programme was declared the winner of a tender announced by the Russian Aerospace Agency (Rosaviakosmos).

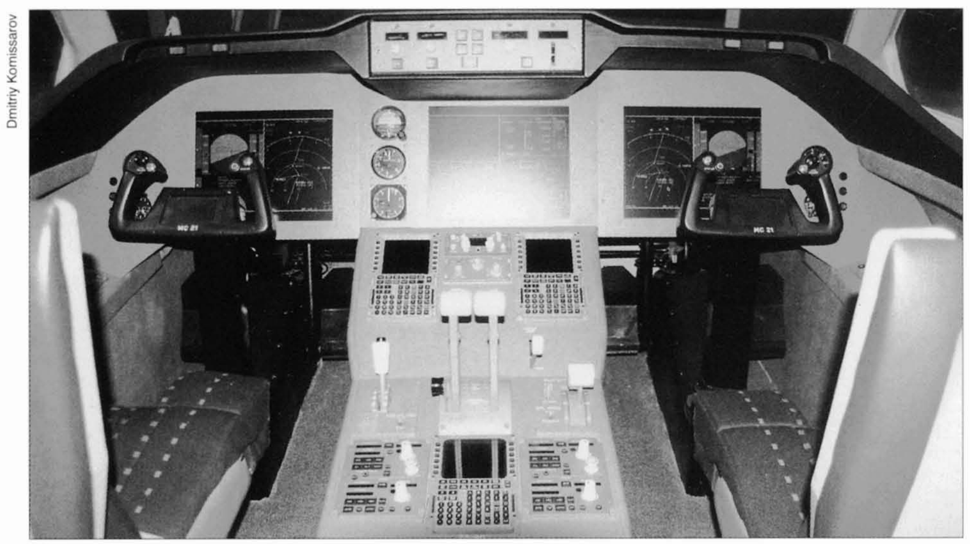

Dmitriy Komissarov

A special team of designers was set up jointly by the two main partners; in mid-2003 it numbered some 60 persons. The overall volume of investments into the programme for the period up to 2015 is estimated at RUR 13.5 billion. Of this amount, RUR 6 billion will be provided from the State budget; the rest is to be sourced through private investment.

Above: This poster from the MAKS-2003 airshow illustrates the appearance of the Ilyushin/Yakovlev MS-21 airliner, which has not changed after the shelving of the Yak-242 programme.

Below and bottom: This flightdeck mock-up of the MS-21 was shown at MAKS-2003. The instrument panel features three large colour liquid-crystal displays, with three control/indication units with keypads on the centre control pedestal. Note that there are next to no electromechanical back-up instruments.

Dmitriy Komissarov


Dmitriy Komissarov

Dmitriy Komissarov

Yefim Gordon archive

Above: This reasonably accurate full-scale mock-up of a two-seat IL-2 is in the open-air display at the Great Patriotic War Museum at Poklonnaya Gora in Moscow.

Left: The wreck of a North Korean Air Force IL-10 coded '54 White'. The aircraft was destroyed by USAF action at a North Korean airfield.

Below: This IL-10M armed with dummy bombs and RS-82 rockets was displayed at an exhibition ground on Frunzenskaya Embankment in Moscow.

Yefim Gordon archive

RART

Above: Except for the absence of the mainwheels (which are apparently undergoing restoration), IL-12 '35141 Red' preserved at the Chinese People's Liberation Army Air Force (PLAAF) Museum at Datang Shan AB is in excellent condition.

Via AVICO-Press

Right: There aren't many IL-14s around now, so the participation of IL-14G 02299 ФЛАРФ (ie 02299 FLARF) operated by the Aviation Enthusiasts' Federation of Russia in Yoozhnyy Ekspress (Southern Express) colours in several Moscow airshows was most welcome. The nose radome hiding an RPSN-2 Emblema radar and the dorsal fairing identify this aircraft (ex-CCCP-48106, c/n 8344001) as a former testbed of unknown nature.

Below: IL-14T '08 Red' (c/n 148001908) preserved at the (now defunct) open-air museum at Moscow-Khodynka was once the personal 'hack' of General Djokhar Dudayev when he commanded a bomber division, hence the VIP colour scheme.

Via AVICO-Press

Polygon Press archive

Above: A Soviet Air Force IL-28 coded '67 Blue' (the code appears black due to the poor quality of the original photo) operated by the Group of Soviet Forces in Germany.

Vyacheslav Martyniuk

IL-18V RA-75676 (c/n 185008605), seen here taxying at Savasleyka AB near Nizhniy Novgorod, is operated by the 223rd Flight Unit State Airline, a commercial division of the Russian Air Force. The aircraft is ex-CCCP-75676 No.2; originally the registration belonged to IL-18B c/n 189001001 which crashed on 2nd September 1959.

Yefim Gordon

Above: Russian Air Force IL-20M '90 Red' (c/n 173011501) at Shaikovka AB. By 1999 this aircraft had been assigned to the Russian Air Force's 929th State Flight Test Centre (the former GK NII VVS) and registered RA-75923 No.2, becoming a testbed for a new mission avionics suite.

Yefim Gordon

IL-22 (IL-18D-36 'Bizon') CCCP-75903 No.1 (c/n 0393610235) belongs to the Special Mission Squadron of the Russian Air Force's 226th OSAP (Independent Composite Air Regiment) at Kubinka AB. It retained the old Soviet prefix and flag until at least 1998.

Yefim Gordon

Above: IL-20RT CCCP-75481 (c/n 173011503) was operated by the Russian Navy's 240th GvOSAP at Ostrov AB as a trainer. It is seen here at its home base in 1996; note the Sukhoi Su-33 shipboard fighters and the Beriyev A-40 amphibian visiting the base on occasion of a parade over St. Petersburg marking the Russian Navy's 300th anniversary.

Yefim Gordon archive

Seen here on the GosNII GA apron at Moscow/Sheremet'yevo-1 in the early 1990s, one of the two IL-24N ice reconnaissance aircraft (CCCP-75466, c/n 187010403) displays Aeroflot's 1973-standard Polar colour scheme.

Yefim Gordon archive

Above: A grey-tailed Aeroflot Russian International Airlines IL-62M produces a puff of smoke as it touches down with a bounce. In the air the IL-62 offers an exceptionally smooth ride (it is virtually immune to turbulence), but the touchdown can be rather bumpy. Note the characteristic asymmetric position of the nose-mounted landing/taxi lights (the port one is located higher than the starboard one).

RART

IL-62M CU-T1283 (c/n 4053823) displays the predominantly white current livery of Cubana.

Via RART

Above: IL-62M 'Salon TM-3SUR' RA-86559 (c/n 2153258) of the Rossiya State Transport Co. takes off at London-Heathrow. The dorsal antenna conduit and the extra blade aerial at the top of the fin are clearly visible. The flag on the tail instead of the usual coat of arms on a red shield identifies RA-86559 as the presidential aircraft.

Dmitriy Komissarov

Above: IL-62M RA-86130 (c/n 3255333) in the old colours of Aviaenergo is towed by a BelAZ-7420 tug at Moscow/Sheremet'yevo-2 on 11th June 1999. The aircraft was jointly operated with Aeroflot Russian International Airlines at the time, hence the small 'From Aeroflot' titles below the forward entry door.

Sergey and Dmitriy Komissarov archive

The first prototype IL-76, CCCP-86712 (c/n 0101), is towed by a KrAZ-214 lorry past the IL-62M prototype (CCCP-86673 No.1, c/n 70303). Until the mid-1970s the colour schemes of Aeroflot's aircraft were as disparate as the types it operated.

Ilyushin Aviation Complex

Above: Seen here on final approach, IL-76TD CCCP-76470 (c/n 0033445291, f/n 3303) operated by Aeroflot's Central Directorate of International Services/64th Flight displays its powerful high-lift devices.

Polygon Press archive

BMD-2 armoured fighting vehicles are readied for loading into Russian Air Force IL-76MD RA-78842 (c/n 1003403069, f/n 7708). The scene is probably Klin-5 AB north of Moscow, as indicated by the stored IL-76s in the background, one of which is in basic Aeroflot colours with red stars (presumably IL-76 *sans suffixe* '601 Black').

Yefim Gordon

Above: Seen here taxying at Zhukovskiy, its home base, IL-76TD RA-76845 *Mikhail Vodop'yanov* (c/n 1043420696, f/n 9304) belonging to EMERCOM of Russia is actually an IL-76MD 'Falsie' (as revealed by the covers over the strap-on chaff/flare dispenser connectors) and was originally marked 'IL-76MD'.

Yefim Gordon

Wearing the non-standard registration ИС 76900 (ie, IS 76900), the IL-76MF prototype (c/n 1053417563, f/n 9001) makes a tight turn during the MAKS-95 airshow.

Yefim Gordon

Above: IL-78M '36 Blue' (c/n 1013405197, f/n 8010) makes a demonstration flight at the MAKS-99 airshow, performing a simulated refuelling of Su-30 '597 White' (c/n 79371010102) and the unpainted Su-30KN '302 Blue' (c/n 79371010302). The fighters have deployed their airbrakes to keep formation with the relatively slow tanker.

Right: The IL-86 prototype, CCCP-86000 (c/n 0101) with the Le Bourget exhibit code 348 on the fuselage.

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Below: More than a decade after the demise of the Soviet Union, the IL-86 continues to be an important asset for some of the Commonwealth of Independent States' major air carriers. Here, RA-86108 (c/n 51483208076), one of several operated by Sibir' Airlines, is seen at Moscow-Domodedovo.

RART

Ilyushin Aviation Complex

Above: The prototype IL-102 in front of the Ilyushin OKB's hangar at Zhukovskiy after repaint in a three-tone camouflage with the serial '10201 Black', with six UB-32A FFAR pods on the wing pylons. The array of weapons in front includes B-8M and B-13 FFAR pods and a KMGU submunitions container. Note the open wing bomb bays.

Ilyushin Aviation Complex

RA-10323, the demonstrator of the IL-103-10 export version fully equipped for IFR flying, in the type's standard colour scheme. Note the strake aerial on the fin characteristic of this version. Unlike most Russian aircraft, the IL-103 is flown from the right-hand seat.

Ilyushin Aviation Complex

Above: The first prototype of the IL-96-300, CCCP-96000 (c/n 0101), cruises over thick overcast during an early test flight.

RART

Above: RA-96012 (c/n 74393201009), the first IL-96-300PU VVIP aircraft, pictured during one of Russian President Boris Yeltsin's foreign trips. The dorsal antenna/wiring conduit associated with the extra comms equipment and the triple blade aerials and two satellite antennas ahead of it are clearly visible.

Ilyushin Aviation Complex

The former first prototype IL-96-300 in the early days of its 'second life' as the IL-96MO, the prototype of the ill-starred stretched version with Western engines.

Ilyushin Aviation Complex

Above: The first prototype IL-114, CCCP-54000 (c/n 0101), was probably the first Soviet airliner prototype to have a non-Aeroflot colour scheme.

Yefim Gordon

Above: St. Petersburg-based Vyborg North-Western Air Transport Co. was the first Russian airline to begin scheduled services with the IL-114. Seen here at Ghelendjik airport, a long way from home, in 2002, RA-91014 (ex-Uzbekistan Airways UK 91001, c/n 1013823024, f/n 0106) wears a very 1970s-style livery.

Ilyushin Aviation Complex

The IL-114T prototype (c/n 1043800207) in its original guise as RA-91005 and with the Le Bourget exhibit code 336.